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AIRLINER CABIN AIR QUALITY

HEARING

BEFORE THE

SUBCOMMITTEE ON AVIATION

OF THE

COMMITTEE ON COMMERCE, SCIENCE AND TRANSPORTATION UNITED STATES SENATE

NINETY-NINTH CONGRESS

SECOND SESSION

ON

AIRLINER CABIN AIR QUALITY

SEPTEMBER 19, 1986

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AIRLINER CABIN AIR QUALITY

FRIDAY, SEPTEMBER 19, 1986

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
SUBCOMMITTEE ON AVIATION,
Washington, DC.

The subcommittee met, pursuant to notice, at 9:30 a.m., in room SR-253, Russell Senate Office Building, Hon. Nancy Landon Kassebaum (chairman of the subcommittee) presiding.

Staff members assigned to this hearing: Patty Hahn, professional staff member and Steve Palmer, minority professional staff member.

OPENING STATEMENT BY SENATOR KASSEBAUM

Senator KASSEBAUM. The hearing will please come to order. Our hearing this morning is on airliner cabin air quality, a subject that has interested the Aviation Subcommittee for some time, and we are particularly interested this morning in reviewing the conclusions that were reached in the National Academy of Sciences Report on Airliner Cabin Environment.

That study was mandated by Congress in 1984 by Public Law 98-466 which was enacted in response to criticisms that existing information on airliner cabin air quality was contradictory and insufficient.

Our legislation required that the Federal Aviation Administration conduct an independent study of a number of issues, and the FAA chose the National Academy of Sciences to prepare the study. We expect this morning to hear distinguished panelists' comments concerning the Academy's conclusions about cabin air quality and environment, emergency procedures, airline regulations, and feasibility of data collection.

I would particularly like to thank Senator Inouye for his continuing interest and leadership in bringing these issues to hearing. I think flying from Hawaii to Washington must be a real incentive to focus on cabin air quality but it is, for any of us who fly long distances, a very important subject.

Senator Inouye.

OPENING STATEMENT BY SENATOR INOUYE

Senator INOUYE. Thank you very much, Madam Chairman. And thank you for the opportunity to have this hearing this morning on a matter that you know is of great interest to me.

I greatly appreciate the promptness with which the committee has responded to the report recently released by the National Academy of Sciences on cabin air quality and I look forward to a very productive hearing this morning.

I first became aware of a problem in commercial aviation environment about 8 years ago, something that I had long suspected; that the quality and quantity of fresh cabin air was greatly lacking and the methods available to rid the cabin of smoke and fumes and protect passengers and crew was nonexistent.

Five years ago, I first introduced legislation to authorize a study of airliner cabin air quality to initiate a thorough investigation of the issues involved, and make a start toward resolving the obvious problems that existed. As you know, hearings were held on this topic in the Aviation Subcommittee in the 97th and 98th Congresses and finally, on October 11, 1984, the bill was signed into law.

Since then, the National Academy of Sciences has been diligently working to answer the questions that were raised in this bill and thus shed more light on the problems that exist and the measures which must be taken to correct them.

So it was with great pleasure that I received my copy of the NAS study which was released in August of this year. In going through this study I was very pleased to find a confirmation of the things I have been saying for years; namely, that the health and safety aspects of the airline cabin are sub par and require immediate attention to rectify; that in many aspects of this issue vital issue is noticeably absent and, as a result Federal standards are woefully inadequate; that a clear mandate needs to be given to a Federal agency to assure America's traveling public a healthy airline cabin environment.

There are many specific findings and recommendations contained in the NAS report which hold great merit and deserve prompt and thorough consideration. Of course, the conclusion that cigarette smoking be banned on commercial flights is the aspect of the report which has attracted the most attention and caused the most controversy.

While this is undoubtedly a very bold and far-reaching step for NAS to take and indeed a suggestion that should be looked into in earnest, I feel that the report contains many other directives that also deserve our utmost attention. These recommendations include:

That maximal air flow and increased air filtering be used with full passenger loads;

That emergency breathing equipment be provided to all cabin crew and should be considered for all passengers;

That preflight briefings include instructions on how to react to an in-flight fire emergency;

That FAA standards for carbon dioxide be brought into line and that ozone standards be enforced;

That a comprehensive program for data collection be established by the FAA and used to formulate new regulations; and

That a single Federal agency be responsible for monitoring and regulating the health aspects of air travel.

I feel that this last recommendation holds especially great significance as we consider this report, as it speaks to the current lack of a mandate to monitor and regulate the health aspects of aviation, including issues that relate to cabin air quality.

Currently there is little focus and direction when it comes to these issues, and as a result we still do not have a comprehensive and effective approach to assuring that the airline cabin is a safe and healthy environment for those who work and travel in it.

I hope that the FAA in its testimony this morning and its written response to the study will focus on this and the other salient points raised by the NAS so that we may set about grappling with the problems that currently exist and formulate an attack plan to solve them.

It has been 5 long years since I first introduced legislation to achieve these objectives, and yet we still do not have a current policy in this area, much less a noticeable improvement in the conditions in question.

I hope that the release of the study and the insights we gain from today's hearing will provide a new impetus to address and resolve these troublesome issues. I know that I am not willing to wait another 5 years or even another 5 months for such an outcome, and I am certain the American traveling public feels the same.

I once again thank you very much.

Senator **Kassebaum**. Thank you.

We would like to call the first panel of witnesses now: Mr. Halfpenny and Mr. Beard.

It is a pleasure to welcome you, Mr. Paul Halfpenny, Vice Chairman, Committee on Airliner Cabin Air Quality, National Research Council, National Academy of Sciences, and Mr. Craig Beard, Director, Office of Airworthiness. Mr. Craig is accompanied by Dr. Jon Jordan, Deputy Federal Air Surgeon of the Federal Aviation Administration.

Mr. Halfpenny, would you like to begin, please?

STATEMENTS OF PAUL F. HALFPENNY, VICE CHAIRMAN, COMMITTEE ON AIRLINER CABIN AIR QUALITY, NATIONAL RESEARCH COUNCIL, NATIONAL ACADEMY OF SCIENCES, ACCOMPANIED BY DR. DEVRA LEE DAVIS, ACTING DIRECTOR, BOARD ON ENVIRONMENTAL STUDIES AND TOXICOLOGY; M.C. CRAIG BEARD, DIRECTOR, OFFICE OF AIRWORTHINESS, FEDERAL AVIATION ADMINISTRATION, ACCOMPANIED BY DR. JON L. JORDAN, DEPUTY FEDERAL AIR SURGEON

Mr. **Halfpenny**. Thank you, Senator.

Senator Kassebaum and members of the committee, I am pleased to have this opportunity to testify today about the findings and recommendations presented today in the committee's recently released report, "The Airliner Cabin Environment: Air Quality and Safety."

My name is Paul Halfpenny. I am vice chairman of the Committee on Airliner Cabin Air Quality of the National Research Council's Board on Environmental Studies and Toxicology. I have 33 years experience as research engineer and design specialist with the Lockheed California Co., in Burbank, and my areas of specialization include environmental controls, air distribution, thermodynamics, heat transfer, fluid flow, pneumatics, waste systems, aircraft systems.

I am accompanied by Dr. Devra Lee Davis who is Acting Director of the National Research Council's Board on Environmental Studies and Toxicology.

In the interests of time, I would like to summarize my written testimony and the conclusions from the executive summary of the committee's report. In addition, I would also like to request permission to place the executive summary of the committee's report in the hearing record.

Senator **Kassebaum**. Without objection.

Mr. **Halfpenny**. Thank you.

At this time I would like to present the major findings and recommendations of the committee's report.

As Senator Inouye said, the investigation was well-outlined by Public Law 98-466 and it spoke to a number of items which the original hearings were concerned about. I would like to summarize our report in basically four sections.

The first of these and the one which probably got the most attention was cabin air quality. The committee reviewed ventilation standards and ventilation parameters for 95 percent of the aircraft which are operated under FAR Part 121 in the United States. In general, we found that the ventilation rate and fresh air per passenger varied from a low of 7 cubic feet per minute to over 50, depending upon the load factor and the design of the aircraft.

However, the committee in analyzing these, found that even at the lowest design ventilation rates for aircraft, where there is no ETS—environmental tobacco smoke—or other contaminants, does not constitute a health hazard.

One of the problems that the committee had in this investigation was a rather serious lack of data on health hazards in aircraft. However, when we looked at environmental tobacco smoke levels in smoking zones, we found that in general they exceed almost every known closed environment and, on that basis, constituted a potential health hazard to the cabin crew who had to work in that environment.

We also found that there are no standards for biological aerosol concentrations in airliner cabins or in any other closed environment. Data on actual concentrations was nonexistent and actually the dose response relationships for many infectious or most infectious diseases is unknown. How many germs does it take to transmit a disease?

We investigated the low humidity aspects of flying. It is quite low. And all of this causes some discomfort. We felt there is no serious health hazard. Humidity, of course, varies inversely with the ventilation rate. The ozone levels that are established by the FAR's in their 1985 issues are not hazardous to most passengers.

We did consider, however, that epidemic disease could result when outside air ventilation is very, very low or below the minimums that we found on airplanes. This might be the case when an airliner is operated without ventilation on the ground. And there was a documented case where there was transmission of influenza—one case in Alaska.

On the basis of this, the committee made a number of recommendations on air quality:

First, we recommend that air flow be actually measured on airplanes. We go beyond the original design parameters and request that somebody check it every once in a while; also that contamination levels be checked.

We recommend that the FAA or other agency verify that airlines are complying with the ozone standards. Of course, the one that the Senator mentioned, the ban on smoking which caused a great deal of controversy and a lot of comment was one of the committee recommendations.

We established a 30-minute maximum for no ventilation. If an airline cannot provide ventilation within 30 minutes, we recommend that passengers be offloaded.

Where aircraft use recirculation, we recommend that they be filtered down to at least a 2 or 3 micron level. We also recommend that when airliners are fully loaded, maximum ventilation be used.

The second area that the committee looked at in detail was fire safety. Here we found a number of things. The airline procedures for cabin smoke control are inadequate. They do not consider ventilation. They erroneously consider pressurization.

We reviewed passenger safety briefings, the written materials and the briefing that the cabin crew gives prior to takeoff. We examined passenger response to these type of briefings.

We also visited the FAA NAFEC facility and reviewed the revised fire test programs and materials development for cabin materials. Regarding fire safety the committee made the following recommendations: We believe that passengers should be informed regarding fire safety, particularly evacuation procedures. We believe that a program should be set up to investigate responses to these type of instructions. Are video presentations more effective than live presentations?

We believe that continued research into materials development and testing for fire resistance be carried out. We also asked that the FAA review the use of protective breathing devices for both crew and passengers. This was previously done a number of years ago by the CAMI—the Civil Aviation Medical Institute—and they reached the conclusion they were not effective. But there have been a lot of improvements in design in those years and we believe that should be reviewed again.

As I mentioned, the committee found that the procedures for fire control in the cabin were very weak and, in many cases, nonexistent. We believe that they should be established; they should be firmly established to maintain maximum ventilation, turn off recirculation, and maintain normal pressurization.

The FAA is doing research into fire control, fire prevention and smoke removal, and we recommend that that be continued.

The third area covered the general term "Other Health Aspects." In this area we reviewed pressurization and cosmic radiation. The committee felt that the current pressurization does afford adequate protection to the general traveling public. However, patients with cardiopulmonary disease might be at increased risk at the low cabin pressures. And, of course, this risk would increase greatly in the event of a depressurization.

The committee reviewed depressurization statistics and found that the number of depressurizations was about three per million flights, which is not a great number.

In general, cosmic radiation in commercial air travel does not pose a serious health risk to the general public. There is, however, a caveat to that. A pregnant flight crew member could be exposed to cosmic radiation levels which would be in excess of three to five full chest x-rays, and these are not recommended for pregnant women during the first or second trimester.

As regarding health aspects, this summarized most of our findings. We have some recommendations on health and I will cover those in our data collection summary. We found generally that there were very few data that we could accept on a scientific basis regarding the quality of air on airplanes. And the health effects, although they have been investigated by a number of investigators, failed to be inclusive enough to be fully meaningful.

The committee believes that there are several kinds of health data which could be collected. First, we believe that health effects on crews—spontaneous abortions, birth defects—this would affect to pregnant cabin crews and flight crews—decreased pulmonary functions, myocardial infarctions, heart attacks and that type, should be collected. They should be compared with base groups so that we have a baseline reference. And then we do recommend strongly that a program to monitor cabin air quality be set up.

This applies not only to airlines, but basically the industry in general has no standards for cabin air quality. Ventilation standards are really based on comfort and odor perception. But health standards, as far as aerosols, microbial aerosols, are not established for any indoor environment. The committee strongly recommends that that be done.

That is a brief outline of our report, Senator, and at this time I would like to thank Dr. Davis, Dr. Rob Coppic and Jim Frasier who were on the staff and did a lot of the work with the committee, and we would like to answer any questions you may have.

[The statement and questions and answers follow:]

STATEMENT OF PAUL F. HALFPENNY, VICE CHAIRMAN, COMMITTEE ON AIRLINER CABIN AIR QUALITY, BOARD ON ENVIRONMENTAL STUDIES AND TOXICOLOGY, NATIONAL RESEARCH COUNCIL

My name is Paul Halfpenny. I am vice chairman of the committee on Airliner Cabin Air Quality of the National Research Council's Board on Environmental Studies and Toxicology. The National Research Council is the operating arm of the National Academy of Sciences and the National Academy of Engineering. I have over 33 years' experience as research engineer and design specialist with the Lockheed California Co., Burbank, CA. My areas of specialization include environmental controls, air distribution, thermodynamics, heat transfer, fluid and compressible flow, pneumatics and waste systems. I have served on the Committee on Airliner Cabin Air Quality for the past 2 years.

I am pleased to have this opportunity to testify today about the findings and recommendations presented in the Committee's recently released report, "The Airliner Cabin Environment: Air Quality and Safety." I am accompanied by Dr. Devra Lee Davis, Acting Director of the National Research Council's Board on Environmental Studies and Toxicology.

A few years ago a series of Congressional hearings reviewed the adequacy of regulations and practices governing the quality of air on board commercial airlines. The questions were originally raised by flight attendants and some passengers who claimed that ventilation in the passenger cabins of airliners was not sufficient. Of particular importance was the revelation that information on airliner cabin air quality was contradictory. To help resolve these issues, Congress asked that the Nation ' Research Council undertake a study of airliner air quality and recommend remedies if problems were discovered. For the past 18 months, a committee has been looking into these issues. The committee was chaired by Dr. Thomas C. Chalmers, of Mount Sinai Medical Center, and co-chaired by Prof. John D. Spengler, of Harvard School of Public Health, and myself. Other members of the committee were Harriet Burge of University of Michigan, Edward Calabrese of University of Massachusetts, Stephen Horvath of University of California, Nan Laird of Harvard School of Public Health, Genevieve Matanoski of Johns Hopkins University, James Melius of NIOSH, Matthew Radnofsky, a fire-safety consultant formerly with NASA, and Donald Stedman, of the University of Denver.

In general, flying on commercial airlines in the United States is not hazardous to the average passenger. However, it is possible, but not unequivocably proven, that flying may be hazardous to the health of cabin crew members and frequent fliers who have long exposure to cosmic radiation, ozone, airborne microbial agents, and environmental tobacco smoke.

A common complaint of air travelers is that "smoky air" from cigarette tobacco smoke causes irritated eyes, dry nasal passages, headaches, and other symptoms. in fact, ozone, and other air contaminants, coupled with low relative humidity, may act synergistically with smoke to increase its effects.

We determined that when the ventilating systems in the newer, fuel-efficient airplanes operate at the lowest rate for which they were designed,the amount of fresh air from the outside entering the passenger cabin can be less than the minimum recommended ventilation set for other enclosed environments where smoking is not allowed. For example,the fresh air flow can be lower than seven cubic feet per minute per passenger in a fully booked economy-class section of an aircraft. This is roughly equivalent to the minimum rate established for trains, subways, and buses—where smoking is not allowed—by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers. Our committee concluded that when cigarette smoke is added to this minimal fresh air flow, the quality of air falls below the level deemed acceptable for other closed environments. Although Federal Aviation Administration has set standards for concentrations of ozone, carbon monoxide, and carbon dioxide in airplane cabin air, it has not established regulations specifying airflow rates in the passenger compartments. The regulations simply require that compartments be "suitably ventilated."

Some of the new airplanes recirculate up to 50 percent of the air. Filters remove some particles from the air, but not gases. This means that many of the irritants in tobacco smoke remain in the air.

No studies have been done of the long-term health effects of exposure to environmental tobacco smoke on board aircraft. Therefore it is necessary to infer the health effects on air travelers from studies of the effects of so-called "passive smoking" on non-smokers in other environments. Some of these studies suggest a clear association of passive smoking with lung cancer and a possible association with an increased risk of heart disease.

Our committee recognized that for most passengers on a short flight, smoky air does not constitute a clear health risk; but it does cause irritation, objectionable odor, and discomfort to many. However, the domestic airline industry employs some 70,000 flight attendants. Their exposure is considerably greater than that of the average passenger. Moreover, these attendants spend much time in the galleys, which often are located in or near the smoking sections. The committee estimated that their exposure may be at levels similar to that of living with a-pack-a-day smoker. Our committee also concluded that not only flight attendants, but also passengers who are frequent fliers and those with special medical problems—pulmonary and cardiovascular diseases, for example—are exposed to potentially serious health risks.

Our committee considered several ideas for alleviating the problem without eliminating smoking. One is to increase the amount of fresh air in the smoking zone. However, this would require redesigning the ventilation system and would bleed power from the engines as well.

Another idea would be to isolate the smoking section, but that too would require redesigning and retrofitting the aircraft. The committee thought all these ideas were probably impractical for existing aircraft.

Another suggestion, surprisingly, is to eliminate separate sections for smokers and nonsmokers. When all smokers sit together and many of them light up as soon as the "no smoking" sign goes off, the ventilation systems on the newer planes are not able to handle that heavy concentration of smoke. Since only about one-third of airplane passengers request seating in the smoking section, our committee didn't think the other two-thirds would accept a return to random seating.

After careful consideration of alternatives, our committee recommends that smoking be banned on all domestic commercial flights. Such a ban will provide four important benefits: It will lessen irritation and discomfort to passengers and crew, reduce potential health hazards to cabin crew, bring cabin air quality into line with established standards for other closed environments, and eliminate the possibility of fires caused by cigarettes.

We considered the fact that some passengers are heavy smokers who may experience withdrawal symptoms on long flights. But we concluded that the various disadvantages of having smoking on board are of more concern than the discomfort of withdrawal. For heavy smokers we offer two suggestions. They might schedule their trips with stopovers to allow for smoking breaks enroute. Our recommendation applies only to domestic flights, so this would be possible to arrange. Or they might find relief by using nicotine substitutes now available by prescription to alleviate the craving for tobacco products.

In addition to smoke, we looked at other aspects of air quality—contaminants such as ozone, carbon dioxide, carbon monoxide, and infectious microorganisms, and other factors such as cosmic radiation, humidity, and air pressure. We were also asked to review safety procedures for fire emergencies.

A crowded airplane with inadequate forced-air ventilation is an excellent environment for spread of airborne diseases. The committee found documentation of an outbreak of influenza that infected 72 percent of the passengers of a plane that sat on the ground for several hours with its ventilation turned off. Therefore, we recommend that full ventilation be maintained whenever the aircraft is full—whether the plane is on the ground or in flight. We also recommend that passengers be removed from a grounded plane within 30 minutes if the ventilation should fail.

The environment inside an aircraft flying at cruise altitude has significantly higher levels of cosmic radiation than does the environment at ground level. Radiation exposure is additive and can be harmful to fetuses. Therefore, we proposed that airlines consider limiting the number of flying hours pregnant crew members may serve.

At cruising altitudes, aircraft maintain artificial cabin altitudes of 5,000-8,000 feet. Passengers with specific health problems, such as heart disease and pulmonary problems may be at increased risk while flying, because of the associated decrease in available oxygen. The committee concurs with the American Medical Association's Commission on Emergency Medical Services which recommends that persons with some chronic diseases consult their physicians before flying as they may need supplemental oxygen.

We reviewed procedures for fire and other kinds of emergencies and believe that instructions for passengers to follow in case of fire are of such importance that they should be included with other safety information given to passengers. We commend the efforts now under way to improve passenger safety briefings and written materials to increase comprehension.

Throughout the study, we were hampered by a lack of data. We could find no records of direct measurements of either concentrations of contaminants in cabin air or of ventilation flow rates. To assist in our study we worked with a consultant from Harvard University to develop a computer model of cabin air flows that simulates distribution of contaminants in different types of aircraft and under various operating procedures. This has been useful, in the absence of direct measurements, in capturing the intricate interdependency of the various factors contributing to airliner cabin air quality. However, we recommend that the FAA establish a monitoring program for air contaminants, air flow, humidity, air pressure, and other factors contributing to the health and safety of passengers and cabin crews.

In our investigation, we found that there is no clear responsibility in the Federal Government for protecting the health of air passengers. The FAA has a clear mandate for air safety, but no federal agency has a specific statutory responsibility for health risks to airline passengers. We recommend that health issues be placed under the purview of a single federal agency.

To summarize: Our committee found that the air quality on board commercial airliners warrants concern. Contaminants—particularly environmental tobacco smoke—make the cabin air quality substandard compared with other closed environments such as trains and subways. To bring aircraft cabin air quality up to an acceptable level, we recommend that all smoking be eliminated from domestic air flights. This ruling will lessen irritation and discomfort to passengers, reduce potential health hazards to cabin crews, and remove the possibility of fires caused by cigarettes.

We also recommend maximum ventilation on the ground and in flight when the plane is fully loaded and removal of passengers within 30 minutes of a ventilation failure. We call upon the FAA to establish a program for monitoring the air quality in airliner cabins. Furthermore, we suggest that some federal agency be given clear statutory responsibility for protecting the health of airline passengers.

Thank you. This completes my testimony.

NATIONAL RESEARCH COUNCIL,
COMMISSION ON LIFE SCIENCES,
Van Nuys, CA, October 31, 1986.

Hon. ERNEST F. HOLLINGS,
U.S. Senator, Committee on Commerce, Science, and Transportation, Washington, DC.

DEAR SENATOR HOLLINGS: Your letter of October 14 was forwarded to my home by the National Academy for response to the Subcommittee's questions.

I have enclosed my answers to the questions on the report by the NAS Committee on Cabin Air quality. Because some of the questions have a number of parts, I have identified each of the sub parts and have coded my answers accordingly.

I have tried to provide enough detail to make the answers satisfactory; however if any of the Aviation Subcommittee would like further information, please have them, or Mr. Palmer (who very kindly provided me with a copy of my remarks to the committee) contact me.

Sincerely yours,

PAUL F. HALFPENNY,
Co-Vice Chairman, Committee on Cabin Air Quality.

QUESTIONS FOR THE NATIONAL ACADEMY OF SCIENCE

(1) In recommending that cigarette smoking be banned, the NAS suggests that this is the only feasible way to improve cabin air quality.
(a) --Why is increasing ventilation not a feasible approach to this problem?
(b) --What are the costs of providing adequate ventilation? (Where are these figures from?)
(c) --Does current aircraft design prevent this from being a viable alternative?
(d) --If so, how could future aircraft ventilation systems be designed to make increased ventilation more economically feasible?
(e) --Could this be done when the interiors of airplanes are renovated every 3 to 6 years?
(f) --Do you believe that the design of aircraft ventilation systems should be based on certain airflow requirements rather than airflow requirements being based on what systems are available?

(a) Increasing ventilation to the level required to dilute environmental tobacco smoke (ETS) to an acceptable concentration would require major changes to the systems on present aircraft.

The aircraft environmental control system (ECS) which provides fresh air to the cabin consists not only of the bleed source, the engine, but the high pressure ducting system, the pressure and temperature conditioning system, and the low pressure manifolds and ducting distribution system. Each of these sub systems is designed to provide an adequate quantity of air for pressurization, temperature control, and ventilation.

I would estimate that the ECS under normal cruise conditions could (for most current aircraft) supply up to 25% more air to the cabin without significant modification to the systems. To increase ventilation in the smoking zone to the level needed, about 100 cfmp, would require extensive redesign and modification to the ECS.

Depending on the location and size of the smoking zone the total increased flow could require modification to all parts of the ECS. If the total increase in air flow were within the 25% figure I have estimated, then all the extra fresh air could be supplied to a smoking zone that comprised no more than 15 to 20% of the total airplane seats. The low pressure distribution ducting would have to be increased in size to supply the smoking zones; however since there are first class, business class and economy class smoking zones, the ducting modifications would be a major task.

Merely increasing fresh air flow to the smoking zones would not solve the problem however. The exhaust flow from the zone would have to be increased to the same level to prevent smokey air from being forced into non-smoking zones. This would require the addition of fans since in all aircraft the exhaust flow is uniform and is controlled using very low pressure drop baffles and orifices located under the floor.

Because the high levels of flow in the special zones would either overcool or overheat the zone if the air were supplied at the same temperature as the rest of the cabin, special temperature control systems would be required involving controllers, sensors, valves and indicators. A complete thermal design would be required to verify that installation of such controls would be compatible with the existing control design and would not cause loss of heating capacity at cold day cruise conditions systems.

In summary, such a modification may not be possible on an engineering basis, and certainly is not practical on an economic or non-discriminatory basis.

(b) The costs of providing ventilation include the cost and weight of the equipment, the direct fuel cost of bleeding the engines, the ram drag to provide heat exchanger cooling and the maintenance costs. The committee did not feel that a complete cost analysis was justified, and the only cost data included in the report was that given in Fig 2-10 which was obtained from AIA. (For your information, I have included an analysis of costs for a generic 200 passenger aircraft similiar to a Boeing 767). The analysis was made by Garrett Corp. in 1979 and presented to the SRE committee in Stockholm.

(c) As discussed in (a), the modification of aircraft is not considered feasible. The current aircraft cabin characteristics (size and passenger density) are not compatible with ventilation rates above 20 cfmp at 100% load factor. Injecting more air than this would create high local velocities and drafts that would be unacceptable to passengers.

(d) Future aircraft could be designed to provide 20 to 30 cfm per passenger, if the requirement were established as part of the design specification. The costs would be real operating costs as discussed above; however with the new generation of higher bypass engines and the current drive toward engines such as the GE UDF (unducted fan), bleed penalties become much more severe than with current engines. It is also likely that bleed flow would have to be shut off during take off and reduced in climb to meet engine performance requirements.

Other options such as filtered recirculated air with absorbers and high performance particulate filters could be developed to improve cabin air quality without the cost of added bleed. Although this is currently done in commercial buildings, the weight penalty of this type of equipment as currently manufactured is a deterrent to incorporation on present aircraft. This type of equipment, if available and designed for the airplane environment could be incorporated in some of the current fleet. Detailed studies would be needed to determine the feasibility of incorporation in each model.

(e) Modifications to install filtered recirculation systems could be a candidate for incorporation during a major aircraft safety check such as a "D" check (25000 hours).

(f) Yes, I do believe that ventilation systems should be based on airflow requirements. These should be established to provide adequate comfort and health conditions. I also feel that the health requirements are not known and that comfort is such a judgement factor that at present there are no well defined standards for airplane ventilation.

> (2) In looking into the economical feasibility of providing greater ventilation in the cabin, did the Academy look at the possibility of a separate generator for the ventilation system rather than the increased bleeding of the engines? If not available, could such a generator be easily built?

The concept of an alternate engine driven compressor (EDC) (generator) is not compatible with current engine design nor is it a viable economic alternative to engine bleed.

Where EDC's have been used they are restricted to constant speed shaft power engines (turbo-props) where a constant speed gear box can be used to drive the compressor. To achieve efficiency and prevent excessive horsepower consumption, inlet guide vanes are required to compensate for altitude/pressure variations. Performance wise, EDC's cannot compete with multiple port bleed engines which minimize bleed penalty at cruise power and provide adequate pressure at flight idle. A cross section of an RB-211 Rolls Royce engine is enclosed for information. It shows the bleed system and the external gear box which would have to be used to power an added compressor. To add another EDC to the gear box to provide the extra air for "adequate" ventilation is not a practical concept.

> (3) You recommend that maximal airflow be used at all times with full passenger loads.
> --Do you mean both in the air and on the ground?
> --Would the establishment of minimum acceptable levels of fresh air per occupant in the cabin be a good way to assure that maximal airflow is provided?
> --At maximal airflow, what ventilation rates could we expect at different passenger loads?

Maximal airflow recommendations were made for both ground and flight. Minimum ventilation standards would assure maximal (adequate) ventilation. At maximal airflow, the fresh air ventilation for current aircraft would vary from 8.6 on a B-737-300 to 18.5 cfmp on a DC-10-10, as shown in Table 2-3 of the committee report. These numbers are cabin averages and do not consider variation between first and economy classes. If maximal were maintained at all times, the ventilation rate would increase as an inverse function of load factor.

> (4) The NAS recommends that a regulation be established to require the removal of passengers from an airplane within 30 minutes or less after a ventilation failure or shutdown on the ground.
> --How did you reach this 30 minute figure?
> --Are you aware that in Great Britain they have a similar standard but with a 5 minute limit?
> --Why is your limit so much greater?

The 30 minute number was a compromise between the recommendations of ASHRAE 62-1981 and what would be practical for an operating airline. Figure 2 of the ASHRAE Standard gives maximum permissible build-up time to reach a level of contamination. Using a 5 cfm steady level as a baseline and from 50 to 75 cu ft of volume per person (extrapolated from the curve), a lag time of from .2 to .3 hours was calculated. Considering the time to load passengers and the average load factor, the committee chose 30 minutes as a practical limit.

The committee would not verify the reported 5 minute limit existing in the UK.

A five minute limit would not be practical, nor could it be justified on a health basis.

> (5) The study suggests that emergency breathing equipment should be provided to all cabin crew, not only those crew members "expected to fight an inflight fire", as proposed in the FAA rulemaking.
> --Do you feel that the provision of such equipment for all passengers should also be considered in the FAA rulemaking?
> --Do any foreign nations currently require, or are currently studying, providing this protection for passengers?
> --Is there currently practical emergency breathing devices that can be used safely by passengers?

The committee's recommendation was that the FAA again investigate the use of emergency breathing equipment by passengers in light of recent developments in breathing devices.

The Ontario Research Foundation recently evaluated 20 devices and conducted extensive tests on six different designs (Ref. 6, Ch. 4 of the report).

As a result of the Airtours B-747 accident in Manchester, England in 1986, the Accident Investigation Branch of the UK Dept. of Transport has strongly recommended that the Civil Aviation Authority require passenger breathing devices in that country. (Page 105 of the Report).

> (6) The Academy recommends that the FAA require that preflight passenger safety briefings include instructions on how to react to inflight fire emergencies.
> (a) --What should such briefings tell the passengers to do?
> (b)--What safety measures are there currently available should smoke fill the cabin?

(a) The Committee recommended that information on proper response to fire emergencies be included in oral and written passenger safety information. Although not specifically noted, it is felt that procedures for evacuation should be included along with information as to how to use an escape slide.

(b) At present there is no safety equipment to protect passengers from cabin smoke. Procedures for control of smoke consist only of fire fighting and emergency descent. The FAA at NAFEC has a program to develop procedures to control smoke.

> (7) On the issue of cosmic radiation, you suggest that the FAA should investigate the amount of radiation flight crews are exposed to.
> (a) --Did NASA provide any data to you in this area?
> (b) --I understand some airplanes, such as the Concorde, are equipped with radiation monitoring equipment. Should we equip the U.S. commercial fleet with such equipment?

(a) The committee reviewed a large number of documents and the report lists 13 references that the committee considered scientifically accurate and pertinent to the subject of cosmic radiation. No specific references to NASA publications are listed.

(b) The Concorde does monitor radiation because it operates at 60 to 70,000 feet which is far above the cruise range of sub-sonic aircraft. No recommendations were made for radiation monitoring on the US Airlines.

> (8) The NAS suggests that a data collection program be established to measure airflow rates and contamination. Should this data--which I assume would show what contamination levels to expect at different airflow rates--be used to set standards for the ventilation of the airline cabin? If not, what would be the purpose of collecting such data?

The objectives of the monitoring program would be to verify that ventilation is as designed by the aircraft manufactures and to collect data on contamination that could be used in a general research program on epidemic disease. The results would be applicable to many closed environments. A possible outcome of the program could be the establishment of standards for ventilation.

> (9) In your report you state that even the "lowest rates of ventilation" present in the airline cabin today are adequate when "smoking is not permitted and other contaminant sources are not present".
> (a) --How much fresh air per passenger is being circulated at these "lowest rates"?
> (b) --What if there is smoking; what can be done under those conditions to improve air quality?
> (c) --Would increasing the airflow rate help?
> (d) --Is it realistic to expect no other contaminants in the airline cabin environment?
> (e) --If other contaminant sources are present, are the low airflow rates still adequate?

(a) The lowest rates of ventilation referred to in the report are in terms of fresh air.

(b) Potential modifications as described in the answer to question 1(e) could improve air quality if there were smoking in the cabin.

(c). Yes. Increasing air flow reduces all contamination levels. The concentration of any constant source contaminant being an inverse function of ventilation. The committee felt that to achieve 80 to 90 percent acceptance would require unreasonably high ventilation rates.

(d) Contamination from volatile organic compounds would be expected in the aircraft cabin; however, because of the high air change rate the committee concluded that levels would be so low as to not constitute a health hazard.

(e) Given the expected contamination from materials and occupants, the ventilation rates are adequate.

> (10) The study found that no data were available on actual measured airflow rates. However, you did list normal flow rates as ranging from "below 7 cubic feet per minute per passenger" up to 50 cubic feet.
> (a) --Where did these numbers come from and how far below 7 feet is "below 7 feet"?
> (b) --Also, it is my understanding that humidity figures documented by the airline industry and submitted by Bertil Werjefelt of ASHA showed humidity rates of up to 59%, reflecting flow rates as low as 3 cubic feet per passenger. Were these figures considered?
> (c) --If such flow rates are sometimes the case, what would the effect be on the occupants of the cabin?

(a) Ventilation numbers were obtained from AIA, the FAA, and a review of manufacturers specifications for the airplanes. As shown in Table 2-3 of the report, the lowest airflow as 6.9 cfmp and applied to a fully loaded DC-10 with two ECS packs at 3/4 flow (One and a half ECS pack equivalent).

(b) The committee found few documented, peer reviewed data on cabin humidity.
The 59 percent humidity reported by ASHA is highly questionable. These reports were not formally published nor submitted to the committee.
Humidity measurements require some degree of expertise and depending on the type of instrumentation used can be very misleading. For example wet bulb/dry bulb measurements can be very accurate IF stable conditions are achieved, air flow over the wet bulb sensor is adequate and the proper corrections for cabin pressure and vapor pressure of water at the dry bulb temperature are made. Non-stabilized temperatures indicate higher than actual humidity. (The type and extent of errors can be calculated using the equations and data from AIR 1609, published by the Society of Automotive Engineers, 1982.)
Electronic humidity meters must be calibrated and corrected for absolute pressure. The committee did not consider the 59 percent data as verified.

(c) At ventilation rates of 3 cfmp, it is highly unlikely that the airplane could maintain pressurization. Most aircraft have uncontrolled leakage through door seals, vents, drains, etc. that amounts to about 5 cfmp based on 100 percent load factor. Thus at 3 cfmp, there would not be enough air to hold cabin pressure. Other cabin effects would be:

- The ECS could not provide enough cooling to handle the passenger sensible heat load.
- The dew point (where moisture condenses) at 59 percent relative humidity, would be about 69°F. All cold surfaces such as side walls, ceiling structure and windows would be wet.
- The CO2 concentration would be about 4000 ppm and this would cause some discomfort with increased rate and depth of breathing. (See attached Figure for CO$_2$ and Humidity levels).
- The concentration of ETS in a smoking zone with this ventilation rate would be intolerable to even the most addicted smoker. (Refer to Fig 2-8 in the report).

(11) The report states that it is not known how often ventilation rates are decreased in the operation of the aircraft. Was evidence found that pilots sometimes reduce airflow during a flight, and indeed is this practice encouraged or allowed by the airlines?

The committee could not determine the frequency of reduction of airflow by the crew. A review of operating procedures showed that for those aircraft in which airflow could be reduced, the airline policy was to reduce flow to some less than maximal level as a normal procedure. This reduction in flow would apply only to those aircraft which had three ECS packs. At present in the US fleet this would include only the B-747, DC-10 A-300, A-310, and L-1011. Aircraft with only two ECS packs are not amenable to operation with reduced flow since single pack operation would provide only marginal pressurization and would not provide good temperature control in either the cabin or the flight station. In summary, the committee concluded that minimal flow is normally used on the fleet aircraft which have three packs with full or partial flow options.

(12) When the Academy suggests that humidity is not a problem, is this based on the assumption that there is adequate airflow, or are you saying that at any airflow rate--even a very low one--humidity is not a problem?

Humidity was considered as an independent parameter and the health effects did not depend on airflow, pressure, or temperature. Humidity is of course related as an inverse function of pressure, airflow and dry-bulb temperature; however there is no synergistic health effect between humidity and these variables in the aircraft cabin.

(13) You recommend that the FAA establish a program to ensure that cabin ozone concentrations comply with DOT standards.
(a) --Are these standards not being met currently, and if not, are ozone levels sometimes dangerous?
(b) --Are airlines required to use equipment to control ozone levels, and if so are they, to the best of your knowledge, using them?
(c) --How much does a simple ozone monitoring instrument cost?

(a) The extent to which ozone standards are being met is not known. The committee knows of no in-flight monitoring programs, thus the extent of ozone exposure in the cabins of aircraft is also unknown. Many of the airlines operating long range aircraft have installed catalytic converters which are very effective in removing ozone. It is not known how long these catalysts will maintain adequate ozone conversion efficiency.

Without compliance to ozone regulations, levels of ozone can be hazardous to health of passengers and crew. Prior to installation of catalysts or charcoal absorbers on the B747SP, ozone levels as high as .5 to 1 ppm were reported.

(b) Airlines are required to limit ozone either by installing catalytic converters or restricting flight altitude based on a statistical prediction of ambient ozone concentration. The committee had no knowledge of the extent that airlines were complying with the rule. This is what prompted the committee's recommendation that ozone be monitored by FAA on a random basis.

(c) Unfortunately ozone monitoring equipment is rather expensive. Because ozone occurs intermittently, a continuous ozone recording is the only practical way to measure it. This requires recorders, ozone monitors with a recordable output, and trained personnel to operate them. The committee did not price a system to monitor ozone, but my personal experience with on board monitoring would say that the minimum basic equipment would cost from 10 to 20 thousand dollars.

(14) What did the computer model you developed show in terms of cabin air quality at different ventilation rates?
--Was this model tested and verified?
--If so are the figures reliable and usable by the FAA to establish minimum airflow rate standards?

The computer model showed how contamination levels varied with occupancy in the various cabin zones with normal ventilation. For example, in Table A-2 of the report, the CO2 levels in the first class section of a B-727 were 919 ppm while in the coach section the CO2 level was predicted to be 1,284 ppm, reflecting the variation in ventilation rate in cfmp. Tables A-5 and A-6, which were both based on a B-767-200 showed the effects of recirculation on the ETS level in the Non-Smoking coach zone. With recirculation the average ETS level increased from .010 to .180 mg/cu meter. Ventilation rate was not varied in the sample cases generated for the report, however this could be done quite simply. One of the useful features of the model is the ability to show how flow between zones can affect contamination levels with normal and reduced ventilation. No actual tests were run to compare results with the model; however the committee is confident that the model does represent typical airplane distribution patterns. The major unknown aspect of the model is the mixing effectiveness of the airplane distribution system in achieving uniform contamination levels. The model assumed uniform cross-sectional mixing. Other unknowns which would ideally be verified in tests are the rate of deposition of contaminants on surfaces, absorption by passengers, and the effects of non-uniform cross sectional distribution on contaminant concentrations.

The model is flexible enough to represent any aircraft and could be used by FAA to establish minimum ventilation standards.

> (15) The NAS states an urgent need for studies of potentially infectious airborne agents under routine flight conditions.
> --Who should do these studies
> --How should these studies best be approached?
> --Should actual on-board measurements be done?

Studies of infectious agents should be done by knowledgeable personnel familiar with testing of aerosol agents. The program could start with the FAA issuing a Request for Proposal to define the requirements and establish the scope of the program. Under this procedure, experts in the field would submit proposals that the FAA could review. The expertise would be obtained at minimal cost to the FAA.

On board measurements would have to be evaluated against testing using full scale cabin mockups. The major aircraft manufacturers have such mockups and in all likelihood would cooperate in a test program. Actual in-flight measurements have the advantage of having typical passenger complements and actual aircraft airflow patterns; however costs for in flight measurements are higher. Detailed comparison of the results expected and the costs of various approaches would be required to finalize the test protocol.

> (16) What was the NAS' evaluation of the current state of FAA records and information with regard to incidents of inflight fires causing the cabin to be filled with smoke and fumes?
> --Should these records be reorganized and recategorized to make them more accessible and thus more easily evaluated?

The FAA Accident/Incident Data System (AIDS) covers failures of equipment, flight interruptions, and any other event that affects the safe operation of an aircraft. Given the number of aircraft and the number of flights in the US every day, a tremendous amount of data is generated and filed. This provides a precise record that can be used in accident analysis. However, the data are focused in such large all-inclusive categories, that retrieval of information on a specific safety aspect is time consuming. In-flight fires for example cover engine fires, cabin fires, cabin smoke (which could be engine oil seal failure), baggage fires, etc. It is possible that better definition of fire types could be coded; however, whenever fire coding is used, any coding errors by the original reporter could result in "lost" data. A detailed review of the data coding options should be made to determine if the AIDS program could be made more useful by addition of coding categories.

> (17) I understand that there is a capability of evacuating smoke and toxic fumes from the cockpit during in-flight emergencies. Is there such a capability for the passenger cabin?
> --If not, would the method used in the cockpit, or other available methods, be effective in the cabin?

Smoke evacuation of the cockpit is a specific requirement of the FAR par 25,831(d). The certification of an aircraft requires that smoke evacuation be demonstrated to FAA inspectors, and the procedure for smoke removal from all sources is a part of the FAA approved flight manual. Since flight crews are provided with 100 per cent oxygen and smoke goggles for use in a fire emergency, a major objective in cockpit smoke evacuation is to ensure that instruments are visible.

In reviewing flight manuals, the committee found that the procedures for smoke removal in event of a cabin fire were inadequate and inconsistent. Because of the size of the cabin as compared to the cockpit, the procedures used for the cockpit, other than the provision to maintain maximum ventilation, would not be effective. Each airplane has some unique air flow characteristics which would make it necessary to develop smoke removal procedures for each model. The FAA program at NAFEC to investigate smoke removal in cabins is highly recommended. A report prepared by Lorengo and Porter of Health Tecna Aerospace Corp under contract to the FAA defines the ventilation characteristics of the principle aircraft used by the US Airlines, and will be of great value in this program. (DTFA-03-84-C-0084).

> (18) The NAS Report states that at certain altitudes, radiation levels of up to 2,000 millirem per hour can be experienced by occupants of the airline carbin. In testimony presented by ASHA, however, NASA information was cited stating that exposures can be as high as 8,000 millirem per hour. Please comment on this NASA information and why it was not included in the Report. Are such levels safe and appropriate, and are they within recommended levels for crew and passengers?

The NAS committee based their predictions of cosmic radiation levels on a number of reports. The normal level of radiation as shown in Chapter 5 varies from .3 to .8 mrem/h. Solar flare activity can increase this value of course. The National Oceanic and Atmospheric Administration reported that 5 years of continuous satellite monitoring showed an average of seven enhanced solar flares a year which increased the radiation level to 200 mrem/h. A RARE event could increase the level to 2000 mrem/h. The 8000 mrem/h level attributed to NASA by ASHA is very misleading. The NASA reference quoted as the source for the number by Mr. Trask of ASHA is a very detailed discussion of ground vs satellite monitoring techniques. The 8000 mrem/h number is a "throw-away" statement in the introduction.

It was used in relation to a "Laminar Boundary Layer Transport" which is only a conceptual airplane, described in a 1978 Boeing paper, "Aircraft in the Next Three Decades". The NASA reference states that radiation "can" increase to rates of 8000 mrem/h above 13km. No frequency of occurrence or specific flight altitude is mentioned. For these reasons, the committee did not include this report. The committee reaffirms the values used in the N.A.S. report, and does not consider the 8000 mrem/h rate appropriate.

> (19) The NAS recommends that with "full loads", maximal airflow rates be used. In your view, what is considered a "full load?" Does an occupancy of 70%, for example, denote a full load?

"Full load" was not defined in the report since to some extent it would depend on the basic design of the airplane and the yet to be defined acceptable aerosol contamination levels in the cabin. However it would seem that for most aircraft any load of 70 percent or more should require maximal airflow.

For certain aircraft such as a B-737-300 which has an 8.6 [redacted] cfmp ventilation rate with maximal flow and a full passenger load, any load above 30 or 40 percent should require two pack flow which is maximal.

> (20) Under Section 1(a) of Public Law 98-466, the NAS was directed to investigate matters relating to cabin air quality, with an analysis of the current standards and industry practices in this area. This was to include an assessment of whether discriminatory practices exist with relation to air quality in the airline cabin (i.e. do the occupants of the cockpit and the cabin receive equal treatment? Do the conditions in the cabin compare with conditions in enclosed ground environments?). As this information was not included in the Report, could the NAS now provide some insight on these issues?

Regarding an assessment of whether ventilation is discriminatory in relation to cockpit and cabin; it is explained in the report why higher ventilation rates are needed in the cockpit; basically to compensate for the radiant heat load that the flight crew is exposed to, and to provide cooling for the avionics. Effective ventilation could be reduced to approach cabin ventilation by ducting fresh air directly to the avionic equipment; however this would have punitive connotations and would certainly be counterproductive in so far as exposing avionics to overcooling and condensation.

Regarding other environments, ASHRAE STD 62-1981 lists a ventilation requirement of 7 cfmp, with no-smoking, for 16 commercial facilities, including lobbies, conference rooms, gambling casinos, lounges, waiting rooms, and dining rooms. The committee did not feel that the ventilation rate in aircraft was discriminatory when compared to these facilities.

Where smoking is permitted, then airline ventilation is far below the levels recommended by ASHRAE. In general, ASHRAE recommends 35 cfmp in smoking environments to achieve an odor level acceptable to 80 percent of persons entering the environment. Since the committee did not attempt to determine to what extent ASHRAE recommendations are complied with in commercial facilities, we could not make a judgement on discriminatory practices in airplanes.

> (21) On page 61 of the NAS study there is a comparison of fuel required, in gallons per hour per passenger seat, versus outside air in cubic feet per minute per passenger (cfmp). On page 60, the study notes that the current price of aviation fuel is between 76 and 86 cents per gallon. Based on this data, it would appear that the cost for fresh air ventilation, according to Boeing estimates for 727's and 747's, is approximately 11 cents per passenger seat per hour at five cfmp. An additional five cfmp costs an extra two cents. To have 20 cfmp, it would cost a total of 26 cents per passenger seat per hour, while 35 cfpmp would cost 43 cents. Do these figures appear correct? --If so, it certainly seems that the cost for providing fresh air for the individual traveller is minimal and could easily be passed along to the consumer if the airlines could not absorb it. Do you feel the benefits of this additional fresh air are worth the minimal extra cost? Please comment.

Yes, the direct fuel costs of 26 and 43 cents per passenger seat hour for ventilation rates of 20 and 35 cfmp are correct based on Figure 2-10 of the report. As discussed in the answer to question No. 1, none of the aircraft currently in service could increase ventilation to a 35 cfmp level without extensive modification.

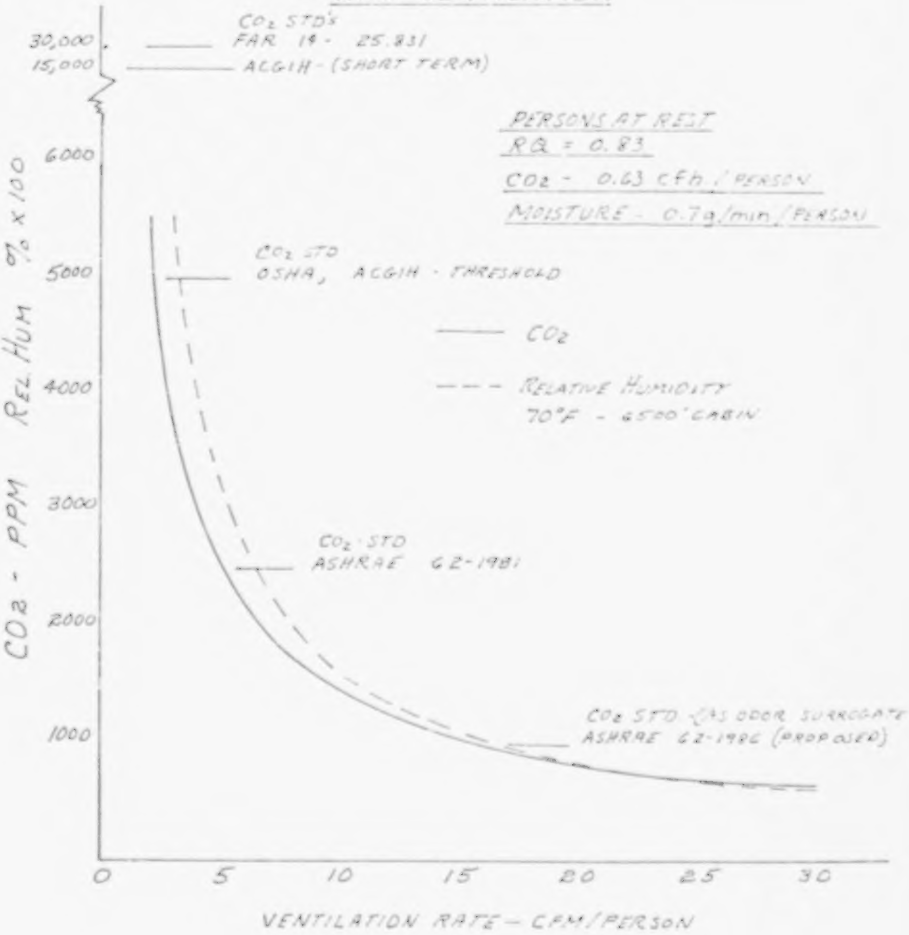
The benefit of extra ventilation in improved passenger comfort is a marketing consideration by the airlines. Although the dollar cost of providing extra fresh air seems very low, the additional fuel burned to provide this ventilation for the US fleet would be significant and must be considered in the context of DOE conservation guidelines.

> (22) What standards and practices exist with regard to occupancy density aboard commercial aircraft?

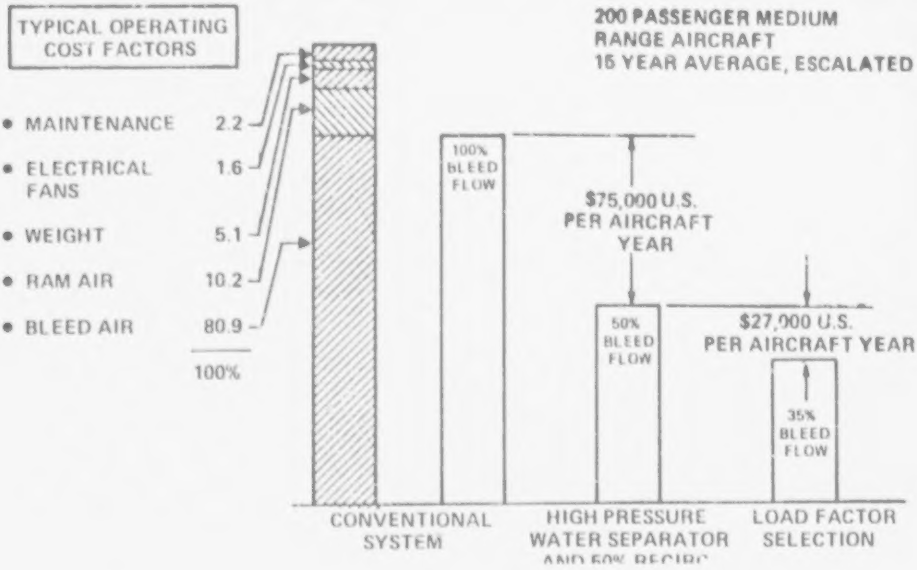
There are no standards for passenger density on board aircraft. The number of seats is limited by the ability to evacuate all of the passengers in an emergency within 85 seconds.

The number and type of seats installed depends on the market place. In the first class section seats are typically 28 inches wide with a 38 to 40 inch pitch. In an economy interior, seats are typically 19 inches wide with a 30 inch pitch. (Pitch is the fore and aft spacing, seat-to-seat).

RELATIVE HUMIDITY AND CARBON DIOXIDE CONCENTRATION WITH VENTILATION



BLEED FLOW SAVINGS-NEW TECHNOLOGY ECS



Senator KASSEBAUM. Thank you very much. If it is all right with you, Senator Inouye, we will go on to hear Mr. Beard.

Mr. Beard.

Mr. BEARD. Thank you, Madam Chairman. We certainly do welcome the opportunity to discuss the recently released National Academy of Sciences study with the committee, and because of the health issues raised in the study I am accompanied by Dr. Jon Jordan, our Deputy Federal Air Surgeon.

We have submitted a written statement, which I would like to summarize in the interest of saving time. The National Academy of Sciences study was formally transmitted to the Office of the Secretary and the FAA on August 12. The extensive 300-page study makes 21 findings and recommendations. Each of these findings and recommendations are currently undergoing a very careful, objective review by a joint working group made up of members from the Office of the Secretary and the FAA.

The Office of the Secretary is involved, since some of the study recommendations fall within the responsibility of the Secretary's office. When the review is completed, the working group's recommendations will be forwarded through the Administrator to Secretary Dole. The Secretary will submit the study, as it was prepared, and her recommendations to Congress.

Because of the time necessary for the deliberate and extensive review of the working group and the fact that we only received the report in mid-August, we doubt that we will be able to transmit the study and the Secretary's response to the study prior to congressional adjournment, as we had originally hoped to do.

If that is the case, then it will of course be transmitted during the opening days of the 100th Congress.

That really concludes my summary. Dr. Jordan and I would be happy to answer questions that you may have.

[The statement and questions and answers follow:]

STATEMENT OF CRAIG BEARD, DIRECTOR, OFFICE OF AIRWORTHINESS, FEDERAL AVIATION ADMINISTRATION

Madam Chairman and Members of the Subcommittee, I welcome this opportunity to discuss the recently released National Academy of Sciences study, "The Airliner Cabin Environment: Air Quality and Safety." Because of the health issues raised in the study, I am accompanied by Dr. Jon Jordan, the Deputy Federal Air Surgeon.

Public Law 98-466 authorized the Secretary of Transportation to commission an independent study by the National Academy of Sciences to review all health and safety aspects of airline cabin air quality for all passengers and crew aboard civil commercial aircraft. The study included but was not limited to a review of the quantity of fresh air per occupant and overall quality of air onboard aircraft; emergency breathing equipment, including toxic fume-protective breathing equipment; and measures, procedures, and capabilities for detecting and extinguishing fires and the removal of smoke and toxic fumes within safe pressurization limits. Public Law 98-466 also required the Secretary to submit a copy of the study to Congress, along with comments and recommendations for legislative, regulatory, and industry changes, as may be necessary.

The National Academy of Sciences study was formally transmitted to the Office of the Secretary (OST) and FAA on August 12. The extensive 300-page study makes 21 findings and/or recommendations. They include recommendations that the FAA review the carbon dioxide standard onboard aircraft; that the FAA re-examine passenger protective breathing devices and consider requiring the availability of such equipment in case of in-flight and postcrash fires; that the FAA consider rulemaking that restricts exposure to cosmic radiation by pregnant flight crew and cabin crew members; that FAA establish a program, subject to peer review, for the systematic measurement, by unbiased independent groups, of the concentration of carbon monoxide, aerosols, ozone, and other particles on a representative sample of commercial flights; and a ban on smoking on all domestic commercial flights. The study also indicated that the health effects associated with air travel should be within the purview of a Federal agency.

The study is undergoing careful review by a joint OST/FAA working group. OST is involved since some of the study's recommendations fall within the responsibility of the Secretary's office.

When the review is complete, the working group's recommendations will be forwarded through the Administrator to Secretary Dole. The Secretary will submit the study "as it was prepared" and her recommendations to the Congress.

Because of the time necessary for the deliberate and extensive review of the working group, and the fact that we only received the report in August, we doubt that we will be able to transmit the study and the Secretary's response to the study prior to Congressional adjournment, as originally anticipated. If that is the case, then it will, of course, be transmitted during the days of the 100th Congress.

Madam Chairman that concludes my prepared statement. Dr. Jordan and I will be pleased to answer any questions you or other Members of the Subcommittee may have.

QUESTIONS OF SENATOR INOUYE AND THE ANSWERS

Question 1. Public Law 98-466 explicitly directs the DOT to submit to Congress at the time of the release of the NAS study, its comments and recommendations regarding the issues raised by the study. It has now been over two months since the NAS Report has been released, and yet we still do not have this information. Moreover, in testimony before the Senate Commerce Committee on September 19th, the agency was unable to make substantial comments on the study. The Committee sincerely hopes that these facts do not indicate that the FAA plans to continue its footdragging on this issue. Does the FAA consider aviation health and safety an important matter, and if so, why has the agency been so slow to respond to the serious problems the Congress and the NAS have raised?

Question 2. When can we expect a complete and thorough report from the FAA commenting on the NAS study and making recommendations for "legislative, regulatory, and industry changes" which the Secretary deems necessary in response to the study, as you are required to do in Public Law 98-466?

In such a report, we assume that the 21 points the FAA identified in its testimony September 19th will be addressed. What specifically are the 21 points you identified and intend to address?

The ATA identified 42 points in its testimony. Why were these other 21 points omitted by the FAA, and will you contact the ATA to determine what these points are, and respond to them also?

Question 3. A main conclusion of the NAS study is that a single agency should be charged with monitoring and maintaining a healthy cabin environment.

Does the FAA feel qualified to be this agency?

What is the FAA currently doing in this regard?

What steps would the FAA take to fulfill this mandate?

Would the agency consider including a program to monitor the health effects on airline crews?

Question 4. The NAS study describes the current lack of data and information in many areas associated with cabin air quality and calls for a new program of independent data collection and evaluation.

What is the FAA currently doing in regard to the collection of information on the concentrations of carbon monoxide, respirable suspended particles, microbial aerosols, and ozone and the measurement of actual ventilation rates, cabin pressures, and cosmic radiation?

Is any actual measurement being done on routine commercial flights in this regard? Will the agency establish a program to collect and evaluate such data as recommended by the NAS?

Will such data be evaluated in order to develop effective and enforceable health and safety standards for the cabin environment?

Question 5. In areas such as radiation, carbon monoxide, and airborne contaminants, the FAA has standards but according to the NAS apparently has no program in place to monitor or enforce these standards. Is this true, and if so will you now seek to set up such a program as recommended by the NAS?

Question 6. Is the FAA currently doing any monitoring of radiation levels in flight and the effect this could have on cockpit and cabin crew?

Will attempts be made in this field considering the NAS recommendation, and the potential danger of certain levels of cosmic radiation on the flight crew?

Question 7. Can the current FAA rulemaking regarding the provision of emergency breathing equipment to certain cabin crew be changed to consider providing these devices for all crew and/or all passengers?

If not, will the FAA consider a separate rulemaking for this, considering the NAS finding that there are now a variety of such devices which show great promise with regard to safety and effectiveness?

Are emergency breathing devices available on FAA owned or operated aircraft?

Question 8. The Report speaks of the need to inform those of the traveling public who may be susceptible to variations of cabin pressure and long periods of low pressurization of the possible dangers of air travel. How do you feel the agency could best interact with the medical profession to get the word out to these people?

Question 9. Does the FAA currently have any standards as to either the operation of the air packs in the cabin or the quantity of fresh air per occupant in the cabin?

As you know, the NAS recommends that maximal airflow be used at all times; do you feel this would be helpful in improving cabin air quality?

How does the FAA feel about the establishment of minimum fresh air standards? Wouldn't such standards provide a scientific basis for the design and operation of the aircraft ventilation systems?

Question 10. The NAS Report points out the urgent need for studies of potentially infectious airborne agents. Will FAA sponsor such a study and, if warranted, use its results to formulate policy to improve conditions?

Question 11. In the course of the study, the NAS developed a computer model of an aircraft ventilation system to calculate levels of contaminants, carbon dioxide, ozone, etc. at different ventilation rates, as well as to test different methods of smoke evacuation during in-flight fires. This model is being made available to the FAA. Will you use it to look at various conditions and scenarios in an effort to improve airline cabin health and safety?

Question 12. Considering that there are far more incidents of in-flight fires than emergency water landings, do you agree with the NAS that pre-flight passenger briefings should include instructions on how to react to in-flight fire situations?

Question 13. In the preparation of the statement of task for the NAS study, Section 1(a) of public law 98-466, stating the very important parameters and guidelines of the study, was apparently omitted. Is there a reason for this?

Question 14. In the area of FAA standards with regard to carbon dioxide and ozone, the NAS found your standards, in general, to be inadequate and unenforced. Will you reevaluate these standards and report to the Committee as to how you intend to see that they are effectively enforced?

Question 15. What standards or industry practices are there with regard to occupancy density aboard commercial aircraft?

U.S. DEPARTMENT OF TRANSPORTATION,
FEDERAL AVIATION ADMINISTRATION,
Washington, DC, November 19, 1986.

Hon. ERNEST F. HOLLINGS,
Ranking Democrat, Committee on Commerce, Science, and Transportation, U.S. Senate, Washington, DC.

DEAR SENATOR HOLLINGS: This is in reply to your October 14 letter concerning the questions that were prepared by Senator Inouye as a followup to the Aviation Subcommittee's September 19 hearing on the National Academy of Sciences' (NAS) report on airline cabin air quality.

Of the 15 questions, we can respond to questions 1, 2, 13, and 15 at this time. The issues raised in the remaining questions will be addressed in the Secretary of Transportation's report to Congress pursuant to Public Law (P.L.) 98-466. I am sure you will agree that it is inappropriate for us to seek to respond to these issues, since they will form a major part of the Secretary's upcoming report to Congress. After the Secretary has submitted the report to Congress, we will be pleased to provide you with any further information that you may wish.

RESPONSE TO QUESTION 1

The NAS transmitted its report, "The Airliner Cabin Environment—Air Quality and Safety," to the Federal Aviation Administration (FAA) on August 12. The NAS chose to publicly release the report on August 13. Our expectation was that the NAS report would be transmitted to Congress by the Secretary of Transportation, and we had hoped to have an opportunity to respond to its recommendations prior to public release.

Immediately upon receipt of the NAS report, a joint Office of the Secretary (OST)/FAA working group was formed to carefully review the NAS study and expeditiously develop a thorough response. As noted in earlier testimony before the Subcommittee on Aviation, we expect the Secretary's response to the report to be ready for transmittal to Congress in the opening days of the 100th Congress.

RESPONSE TO QUESTION 2

All of the points mentioned by the FAA in its September 19 testimony will be addressed in the Secretary's report. The working group assigned a number to each of the 21 recommendations outlined in the Executive Summary of the NAS report. A list of these recommendations is enclosed.

We have been in contact with the Air Transport Association of America (ATA) regarding its count of 42 points as stated in its testimony at the hearings. The majority of the points identified by the ATA were taken from the body of the NAS report. Discussions between the FAA and the NAS indicate that these points were included as commentary and were not intended to be specific recommendations. The majority of the ATA's points correlate with or are embodied in the NAS recommendations already being addressed by the working group. We believe that the recommendations made by the NAS, as outlined in the Executive Summary of its report, encompass the areas of concern mandated by P.L. 98-466.

RESPONSE TO QUESTION 13

The statement of work in the FAA/NAS contract for the cabin air quality study of airplanes used by the airlines was prepared with the full intent of carrying out both the mandated tasks and spirit of P.L. 98-466. During the contract negotiations and in the course of the study, P.L. 98-466 was discussed between the FAA and the NAS. We do not believe that a verbatim restating of the guidelines and parameters outlined in Section 1(a) of P.L. 98-466 would have affected the outcome or findings of the NAS report in any regard, given the full awareness and appreciation of both parties of the Act's requirements and purposes.

RESPONSE TO QUESTION 15

There are no standards or industry practices with regard to occupancy density aboard commercial aircraft.

In closing, I would like to assure you that the FAA shares your concern for the health and safety of airline crewmembers and passengers. We are making every effort to assist in the development of a timely and thorough report to Congress on these important issues.

I trust this responds to your request. Again, I would like to express our willingness to provide you with any additional information that you may wish after the Secretary has submitted the report to Congress.

Sincerely,

William Sullivan
(For M.C. Beard, Director of Airworthiness).

Enclosures.

Recommendations Made by the National Academy of Sciences' (NAS) in Its Report, "The Airliner Cabin Environment—Air Quality and Safety."

1. "The Committee believes that the health effects associated with air travel should be within the purview of a Federal agency."

2. "The Committee found that, if the lowest rate of ventilation permitted by current equipment design were used under conditions of full or nearly full passenger loads, the resulting ventilation rate would be at the minimum determined to provide acceptable air quality when smoking is not permitted and other contaminant sources are not present. In the absence of sources of contamination, this rate does not constitute a health hazard."

3. "A data collection program that measures airflow and contamination in airplane cabins should be implemented."

4. "The FAA standard (on carbon dioxide) is much higher than standards for other confined environments. The Committee recommends that the FAA review its carbon dioxide standard."

5. "Therefore, the Committee suggests that FAA carry out a carefully designed program to ensure that cabin ozone concentrations comply with Department of Transportation regulations."

6. "The Committee recommends a ban on smoking on all domestic commercial flights, for four major reasons: to lessen irritation and discomfort to passengers and crew; to reduce potential health hazards to cabin crew associated with ETS (environmental tobacco smoke); to eliminate the possibility of fires caused by cigarettes; and to bring the cabin air quality into line with established standards for other closed environments."

7. "Because a likelihood of occurrence of epidemic disease when forced-air ventilation is not available on the ground has been demonstrated, the Committee recommends that a regulation be established that requires removal of passengers from an airplane within 30 minutes or less after a ventilation failure or shutdown on the ground and maintenance of full ventilation whenever onboard or ground air-conditioning is available."

8. "The Committee also recommends that maximal airflow be used with full passenger complements to decrease the potential for microbial exposure and that recirculate air be filtered (to remove particles larger than 2-3 um) to reduce microbial aerosol concentrations."

9. "The Committee concluded that current pressurization criteria and regulations are generally adequate to protect the traveling public. However, the medical profession should use a more efficient system to warn those with existing medical conditions who are more susceptible to changes in pressure or to long exposure to low pressure that there might be some hazard to their health."

10. "FAA should consider rule-making that restricts exposure of pregnant flight crew and cabin crew members. In addition, FAA should investigate total radiation exposure of flight crew and cabin crew members through the use of a statistical sample of full-time employees and should require airlines to provide precautionary information to their flight attendants about radiation exposure."

11. "The Committee approves of current efforts to base passenger safety briefings and written materials on empirical testing of comprehension and retention."

12. "The Committee suggests that FAA or appropriate industry organizations consider the advisability of developing an empirical research program to examine passenger response to safety instructions under routine and emergency conditions and revise them as appropriate. Consideration should be given to running some quizzes

during a flight to see, for example, what proportion of passengers have retained the key features of the safety briefing."

13. "The Committee recommends that FAA require that information on proper response to fire emergencies be included in oral and written passenger safety information."

14. "The Committee feels that continuing research (fire safety) is also needed in materials development."

15. "The Committee noted that current emergency procedures for smoke removal recommend that the cabin be depressurized to 10,000 ft. This procedure is ineffective and should be discontinued."

16. "However, there are generally more crew members than fire extinguishers, and the Committee recommends that FAA review the proposed rule on protective breathing devices for crew members to ascertain the desirability of supplying such equipment for all crew members, rather than limiting it to the persons expected to be involved in firefighting. In addition, the Committee suggests further evaluation of the potential of emergency breathing equipment for all cabin crew members to improve safe and expeditious evacuation of passengers in fire emergencies."

17. "The Committee recommends that FAA re-examine passenger protective breathing devices and consider requiring that such equipment be available in case of in-flight and postcrash fires."

18. "The Committee was charged with performing a comparison of foreign industry practices, regulations, and standards, and has gathered relevant information applicable to the issues addressed in this study. Although some differences from those in the United States have been noted, they do not appear to be significant. The Committee feels that greater effort along these lines is not warranted."

19. "The Committee therefore recommends that FAA establish a program for the systematic measurement, by unbiased independent groups, of the concentrations of carbon monoxide, respirable suspended particles, microbial aerosols, and ozone and the measurement of actual ventilation rates, cabin pressures, and cosmic radiation on a representative sample of routine commercial flights. These findings should be subjected to peer review."

20. "The Committee recommends that FAA establish a program to monitor selected health effects on airliner crews."

21. "The Committee recommends that FAA collect these data (uses of recently mandated medical kits) in such a way as to permit comparison of onboard incidents with those in other settings."

Senator **KASSEBAUM**. Thank you very much.

Senator Inouye, why don't I turn to you to lead off the questions?

Senator **INOUYE**. The study suggests that a single agency be responsible for the regulation of the health aspects of air travel. Which agency do you feel would be the most appropriate, and how would you rate the strengths and weaknesses of possible agencies such as FAA, OSHA, NIOSH, in this regard?

Mr. **HALFPENNY**. Well, I would believe that the FAA would be the likely candidate, even though they are basically a safety group and not a health group, but they have most of the background material on airplanes. They know how airplanes work.

If you bring in an unfamiliar agency they would have to be educated up to the particular characteristics of airplanes, possible synergistic effects of ventilation, pressure, humidity.

My recommendation, Senator, would be that it be a branch of the FAA. That is personal.

Senator **INOUYE**. In recommending that cigarette smoking be banned, your study suggests that this is the only feasible way to improve cabin air quality.

What about increasing ventilation?

Mr. **HALFPENNY**. Of course, that is one of the things we did look at. One of the problems is that to establish a smoking level which might be consistent with smoking levels that ASHRE recommends would require very, very high ventilation rates which would be precluded by present design.

Current airplanes which supply 8 or 10 cubic feet per person would have to increase this at least an order of magnitude, tenfold, to reach the levels of smoking in a smoking zone that would be nonirritating.

Senator **Inouye**. What are the costs of providing adequate ventilation?

Mr. **Halfpenny**. I am sorry, sir?

Senator **Inouye**. How much would it cost to provide adequate ventilation?

Mr. **Halfpenny**. Well, there are a number of costs, of course. The first would be the direct fuel cost which, on the basis of pure ventilation, does not seem to be a significant number, costing maybe 2½ to 3 gallons of fuel on a transcontinental flight per passenger.

But the other costs which would include providing the equipment, redesigning airplanes, increasing the distribution duct sizes, air-conditioning packs, I do not know. I suspect that it would be a very big number to increase ventilation by a factor of 2 or 3 or 4.

Senator **Inouye**. It has been suggested that it might cost about 2 cents per ticket. Would that make sense?

Mr. **Halfpenny**. No; I believe that the direct fuel cost alone, which is the number which is quite often quoted, with fuel at 80 cents a gallon, would cost $3 or $4 on a transcontinental flight per ticket. But when you divide this by a load factor, that would double the cost, and when you multiply this by the number of hours and number of flights flown in the United States, it turns into a significant number.

NASA did a study with McDonnell Douglas on the costs of fuel on airplanes on a DC–10 and came up with conclusions like $1 million per year per airplane for fuel.

Senator **Inouye**. And each aircraft carries how many million?

Mr. **Halfpenny**. I am sorry, sir?

Senator **Inouye**. Each DC–10 carries how many passengers per year?

Mr. **Halfpenny**. Oh, I would have to ask Mr. Withee from Douglas, but 296 passengers times 50 percent times 3,000 hours—it is a lot.

Senator **Inouye**. Does the current aircraft design prevent this from being a viable alternative—increasing ventilation?

Mr. **Halfpenny**. To the levels that the committee felt would be needed, yes.

Senator **Inouye**. Have you discussed the matter of aircraft ventilation with aircraft designers and manufacturers?

Mr. **Halfpenny**. Yes.

Senator **Inouye**. And what do they say about the feasibility of improving ventilation?

Mr. **Halfpenny**. Well, there is room for improvement in the sense that many airplanes today operate with less than full capacity. That is an airline option, not a manufacturer's option. Manufacturers design airplanes to provide a specific number of CFM per person.

The airlines may choose to run at less than full capacity, may increase the number of seats, all of which tend to reduce ventilation. So there is some room for improvement.

Senator INOUYE. When you speak of maximal airflow for full passenger load, are you talking about in the air as well as on the ground?

Mr. HALFPENNY. Yes, sir.

Senator INOUYE. How did you reach your 30-minute figure as to the maximum time that passengers should be left on a nonventilated aircraft?

Mr. HALFPENNY. That was sort of a compromise. We looked at some data that ASHRE had prepared which showed how rapidly contaminants build up in a closed environment. And between 20 and 30 minutes, the levels would reach the same concentration that would exist under steady state minimal ventilation. In other words, if you had 6 or 7 CFM per person, steady state, you would have a given concentration. You would reach that in 20 to 30 minutes.

We felt that anything less than that would not be a practical aspect for airlines.

Senator INOUYE. I have been advised that in Britain, it is a 5 minute limit.

Mr. HALFPENNY. I heard that. Somebody told me that, and we could not verify that. We reviewed the regulations in England and we could not verify the 5 minute thing. I do not know that.

We could possibly review that again, Senator, but I could not find that number.

Senator INOUYE. One of your recommendations calls for emergency breathing equipment to all cabin crew, not only those expected to fight an in-flight fire. I think statistics indicate that just as many people die of fire and smoke in aircraft accidents.

Do any other nations currently require or are they currently studying providing this type of protection for passengers?

Mr. HALFPENNY. I do not know of any regulations that require it. But I do know that CAA, which is the British regulatory agency, is reviewing the use of smoke hoods, and I believe that the Canadian regulatory agency is also reviewing it.

Senator INOUYE. Do you think that the rulemaking agency should also consider a provision that passengers be provided with such equipment?

Mr. HALFPENNY. Yes; that was one of our recommendations; that at least they review this. I might amplify that. The early tests that were run by CAMI were really based on escape from an airplane on the ground and they rejected the hoods on the basis that they would impede escape.

But a couple of recent accidents—the Cincinnati accident—pointed out the risks of in-flight cabin fires. And under those conditions, I believe the FAA should relook at the use of hoods for in-cabin flight fires.

Senator INOUYE. Are there currently practical emergency breathing devices that can be used safely by passengers?

Mr. HALFPENNY. I believe there are a number under development that afford some real protection for passengers; yes.

Senator **Inouye**. Have these been tested or studied by this committee?

Mr. **Halfpenny**. No, sir; we did review some research reports from a Canadian group that has run some tests on some of these units. The committee did not do any of its own testing or other review.

Senator **Inouye**. Your study strongly recommends improved data collection. Who should be responsible for such collection of data?

Mr. **Halfpenny**. Well, that is hard to say. I believe it should be put together in a program by the FAA, again because of their knowledge of airplanes and airplane systems. And whether it be done by FAA people or be contracted to some testing group, some development group, some academic group, I do not know that.

I do not have a good firm recommendation. Dr. Davis, you don't have an idea on that, do you?

Dr. **Davis**. Let me just comment that I think it is important that whoever is responsible for this has an independence and therefore their results will receive some credibility.

That is clearly important, given the long nature of the interest that this Congress has expressed in this problem and the difficulties in obtaining data that the committee finds.

Senator **Inouye**. As a passenger, what agency would you consider as having the required independence?

Dr. **Davis**. Well, I was not necessarily thinking that this would be an agency per se so much as an independent advisory activity that would have to be peer reviewed and would work in full sunshine environment so that there would be no question about the openness and the neutrality and the objectivity of the results, because these results are of tremendous importance both for public policy and for the economy.

Mr. **Halfpenny**. If I might comment, Senator, when we did some of our studies, we had meetings with various agency representatives, including EPA and OSHA and I was impressed with the technical ability of the EPA people and their knowledge of testing that type equipment. That is a logical candidate. They do have the equipment. They have the knowledge and the background.

Senator **Inouye**. Do EPA and OSHA collect data?

Mr. **Halfpenny**. That I do not know.

Dr. **Davis**. EPA has a program of research on indoor air pollution which is a modest program, but they have over the years developed the analytic methodologies for assessing a number of indoor air pollutants. And in a sense, the cabin air environment is simply an example of indoor air pollution. There is no escape, so that the air that is there is what you have; you cannot open the window, so to speak, but you do take in outside air.

EPA has a small program in this area and has developed some work on integrated environmental exposure assessment to the indoor environment. So they would be a candidate in that regard.

Senator **Inouye**. Mr. Beard, I gather from this report that the FAA has gathered no data; is that correct?

Mr. **Beard**. That is correct.

Senator **Inouye**. Why hasn't the FAA maintained a collection of data?

Mr. **Beard**. On the quality of cabin air?

Senator **Inouye**. Yes.

Mr. **Beard**. We have not seen a need to date for doing that.

Senator **Inouye**. Even, if this committee, for the past 5 years has been suggesting that it might be well if you initiated a study?

Mr. **Beard**. That is correct. We have not collected the data. We are, however, reviewing that recommendation in the report and giving it serious consideration. We will be responding to the committee on that issue.

Senator **Inouye**. You have had this report since August 30. How long will it take before this committee can receive some sort of response?

Mr. **Beard**. We were targeting a 60-day time period. We did not have any insight into the recommendations and the data of the report until we did receive it. We feel that this time is necessary to really review this extensive report and the data in it, and to give it an indepth and objective review.

As we said, we had hoped to get it to the Congress before it adjourns and we certainly will have it to the Congress early in the 100th Congress.

Senator **Inouye**. Do you require aircraft manufacturers to submit designs to the agency for study, for approval or disapproval?

Mr. **Beard**. The aircraft manufacturers submit their designs to us for evaluation against our standards. We then either approve or disapprove them based on the Federal Aviation Regulations.

Senator **Inouye**. On what basis did you approve their ventilation system?

Mr. **Beard**. Against compliance with FAR 25, sir. Federal Aviation Regulation 25.

Senator **Inouye**. And what does that regulation say?

Mr. **Beard**. It does require a specific quantity of ventilation. It is a very subjective regulation. The only quantitative value in there is the carbon dioxide value, and that is the subject of one of the recommendations, and we believe that is one that certainly does need work.

Senator **Inouye**. Is the basic requirement comfort or health?

Mr. **Beard**. I do not believe we attempt to address comfort requirements. We do attempt to avoid health hazards or hazards that may result in a fatality from damage to the body.

Senator **Inouye**. But you have no studies, so you have no idea whether health hazards are there?

Mr. **Beard**. That is correct.

Senator **Inouye**. At this stage do you think that data should be collected?

Mr. **Beard**. I am really not prepared to answer that question. As I said, that recommendation is being reviewed pretty carefully by the Joint Office of Secretary and FAA Working Group against the data provided to us and the information provided to us by the National Academy of Sciences.

Senator **Inouye**. From your background and experience, do you think that the present configuration of aircraft and the ventilation system would make it possible for the spreading of epidemic diseases, as suggested by the study—influenza, to be specific?

Mr. **Beard**. My personal opinion is that I have not seen data or information prior to this report that really gave us the hard data we needed to come to that conclusion. However, there is considerable data in the report that will be given a very thorough review.

Senator **Inouye**. When the flight crew organizations began calling upon the FAA, I believe about 8 or 9 years ago, did you take their concerns seriously?

Mr. **Beard**. Well, I think we take everybody's concerns seriously, but I think what we do look for is hard data that we can work with. Up until having received this report, we simply did not have that hard data, nor was it our view that there was that hazard.

Senator **Inouye**. You wanted some other agency to collect the hard data for you. You didn't think it was your responsibility?

Mr. **Beard**. No, sir; we did not believe that there was evidence, sufficient evidence to indicate a health hazard to warrant the expense of collecting the data.

Senator **Inouye**. I gather you must travel a lot. Do you travel a lot?

Mr. **Beard**. Yes, sir; I do.

Senator **Inouye**. Long flights?

Mr. **Beard**. Yes, sir.

Senator **Inouye**. I travel on an average, in the last 18 years, 21 flights to Hawaii per year.

Mr. **Beard**. Sir, I could not compete with that.

Senator **Inouye**. I spend about 23 days up in the air per year. And I find that at the end of most of my flights I have a sniffle or I have a cold. Is that your experience?

Mr. **Beard**. It has not been my experience. I travel internationally considerably, and have had trips—not as frequent as yours, certainly—but from the United States to Tokyo or Europe. I have experienced a dry throat. I generally adopt the practice of drinking a lot of fluids, such as water and orange juice. I have not really had any personal problems in that respect.

Senator **Kassebaum**. Senator, would you yield at that point?

Senator **Inouye**. Yes.

Senator **Kassebaum**. You mentioned water. I find it very difficult to get a glass of water on our domestic flights, but it is routinely offered on foreign carriers. Is there any reason for this difference?

Mr. **Beard**. I generally find water near the lavatories. They have a water dispenser with little paper cups.

Senator **Kassebaum**. Thank you.

Senator **Inouye**. You are the experts here. I have been told that the human body requires a certain level of humidity in the air. In the aircraft cabin, how do we get this humidity? What provides it? It is a closed environment. I do not suppose anything comes in from the outside when you are 30,000 feet up there.

Mr. **Halfpenny**. No; when you are at 30,000 feet or any cruise altitude, the absolute humidity is down in the 1 grain per pound. That is extremely dry, essentially zero. And in most analyses, you consider it zero.

So most of the moisture in the cabin is generated by passengers—passenger breath, breathing.

Senator **Inouye**. You mean I get my humidity by taking in your breath and perspiration?

Mr. **Halfpenny**. And vice versa. Yes, sir.

Dr. **Davis**. In fact, in the discussions with the committee it was commented that the measure of actual humidity in the air is actually an indicator of the measure of the ventilation rate because if your humidity in the cabin is a certain high level, that would suggest that your circulation rate might be low.

The humidity is building up, reflecting that. This is an indirect way of estimating circulation on the basis of humidity because there is no independent means of introducing water in the cabin on our domestic flights.

But I think there was some discussion about the fact that some foreign airlines had this capability. Is that correct?

Mr. **Halfpenny**. Yes. There are humidification systems which have been used. One of the problems on airplanes is that there are so many cold surfaces, that to raise the humidity to the kind of comfort levels that we are familiar with, Senator, in Hawaii where the humidity is, I consider, very comfortable—I like the higher humidity myself—but to raise it to those levels you would reach a dew point where water would condense on all the cold surfaces. Even sidewalls would be running wet.

So you are generally limited to 20 percent as an upper limit on an airplane.

Senator **Inouye**. Is the air cabin quality in the cockpit and the quality in the rest of the aircraft the same?

Mr. **Halfpenny**. No, sir. One of the things that the committee looked at was variation throughout the airplane, not only in the cockpit, but say first-class sections or business class versus tourist class.

This variation is due to the fact that a certain amount of air has to be supplied just to maintain pressure and to maintain cooling. And the passenger load is only a portion of it.

So, in the cockpit where the total airflow might be as high as 3 or 400 CFM with a crew of two or three, which would be very high ventilation rate, that air is really being used to provide cooling or heating; it is really not put in there for ventilation.

In those cases, of course, the relative humidity is very, very low; sometimes less than 3 or 4 percent. Very, very dry.

Senator **Inouye**. That is in the cockpit?

Mr. **Halfpenny**. Yes, sir.

Senator **Inouye**. Is there a variation on the quality and quantity in different classes—economy, first-class?

Mr. **Halfpenny**. Yes, sir. It is primarily due to the fact that when airplanes are designed, usually the airflow down the cabin is uniform, and this gives the airline a lot of flexibility in how they arrange their cabins. If you have the first-class section up in front or in back or if you have an all one-class airplane, everybody gets about the same air.

But the seating density in first class is probably one-third—well, maybe two-thirds of that in the tourist section. So, these people are going to get 1½ times as much air, just on the basis of the way air is distributed.

Senator **Inouye**. So, if you want more humidity, you go to the tail end, the economy section?

Mr. **Halfpenny**. Right. That is right.

Senator INOUYE. How many air-conditioning packs or systems do you have in, say, a DC-10, these jumbo jets?

Mr. HALFPENNY. A DC-10 has three packs. The light bodies, the 1011, DC-10, 747 are all three packers.

Senator INOUYE. Are all packs operating when they are in flight?

Mr. HALFPENNY. Usually not.

Senator INOUYE. Usually not?

Mr. HALFPENNY. Yes. Again, it depends on the airline and the operation.

Senator INOUYE. Why?

Mr. HALFPENNY. Again, it is for fuel and it is also because when the design of these airplanes began, three packs were installed to increase dispatch reliability, because the airplane is certified to meet pressurization criteria with two packs running.

These packs were essentially oversized on the total capability of the airplane and the ability to meet the airplane's needs.

I was very familiar with the L-1011 and one of the reasons that three packs were put on was so that you could achieve very, very high dispatch reliability. You could go with two of the packs operating. This allowed you to have one pack fail.

If you had an airplane like a 727, 737, which is a two-pack airplane, and one is inoperative, you cannot go or you are limited to 25,000 feet, which is not a practical cruise altitude.

So, the third pack was really a redundant pack. However, it provided the extra margin of ventilation and cooling. Quite often, inflight airplanes have excessive capability to heat or cool. You can certainly cool an airplane in flight with two packs. So, you meet your cooling requirements and your air distribution requirements with two packs very nicely, and so for purposes of economy, quite often airlines will shut a pack down.

Senator INOUYE. My final question—and I would like to submit the rest and ask for a response—whenever I take a flight, a long flight, we are given safety instructions, either in person or by film. And they are always talking about this thing that falls out from the top and there is a little cup that you put on your face.

What sort of air comes out through that tube? Is it a special air?

Mr. HALFPENNY. That is oxygen, sir. It is either gaseous or chemically generated oxygen that is supplied to you and it is an enrichment. Craig, I am sure, knows more about this than I do, but it basically provides augmented oxygen to meet your basic oxygen requirements at altitudes up to 15,000 feet.

Senator INOUYE. Does that have any effect upon smoke?

Mr. HALFPENNY. No, sir. It only provides, I think in general, about one liter per minute. I think that is about the rate, where your normal breathing rate is from 12 to 18. So you are still breathing 10 to 12 liters per minute of cabin air.

Senator INOUYE. So, if there is smoke in the cabin, you are taking the smoke, notwithstanding the fact that you have face masks?

Mr. HALFPENNY. Yes, sir. There would be very, very slight reduction. It would have no significant effect on cabin smoke. Right.

Senator INOUYE. So, smoke level can still be dangerous.

Mr. HALFPENNY. Absolutely. They do not provide protection against toxic cabin smoke or cabin fire. It is strictly depressurization. As a matter of fact, I know in the Boeing manuals, they do not recommend deploying the oxygen masks in the event of fire. It could lead to a false sense of security.

Senator **INOUYE**. Do you think it does?

Mr. **HALFPENNY**. Yes; definitely. I think people would breathe that and they would think they are doing fine. And it would be no protection. Of course, there is danger of putting more oxygen onto a fire, too, which is bad.

Senator **INOUYE**. Thank you very much.

Senator **KASSEBAUM**. Mr. Halfpenny, on what do you base your recommendation that the practice of depressurization at the time of cabin fire be discontinued?

Mr. **HALFPENNY**. We could not really find a good basis for why anybody was doing it. I believe it is an old anachronism that developed in removing cockpit smoke, where the quick depressurization will give you one rapid air change, but steady state, a burning fire will produce essentially a constant mass of smoke and so even though the ventilation rate in cubic feet per minute might be increased, the smoke generation rate would also increase at the lower pressure.

It has no effect on burning. Our basis was that we believed that under an emergency, if you depressurize an airplane to 10,000 feet, which requires some manual operation of the pressurization control, you are really accomplishing nothing as far as controlling smoke and you are more likely accomplishing a depressurization.

You are exposing yourself to another problem you did not have in the first place.

Senator **KASSEBAUM**. Mr. Beard, has the FAA analyzed the effects of depressurization as an emergency response to cabin fire?

Mr. **BEARD**. We are conducting research and development on the best procedures for smoke evacuation and maybe some design changes which may aid in smoke evacuation.

So there is ongoing research on that subject at this time.

Senator **KASSEBAUM**. Mr. Halfpenny, in recommending a ban on smoking, what data base did you use to evaluate the hazardous effects of smoking?

Mr. **HALFPENNY**. We had some presentations by EPA members and I believe OSHA members who gave us data that said passive smoking in effect did constitute a health hazard if you were in a smoking zone.

Senator **KASSEBAUM**. If you are in a smoking zone.

Mr. **HALFPENNY**. Yes.

Senator **KASSEBAUM**. Am I then correct in concluding that the data you relied upon was based upon samples taken from smoking areas rather than samples of overall average cabin air?

Mr. **HALFPENNY**. Our recommendation really recognized that you probably could not justify any kind of hazard to the average passenger in a nonsmoking zone; that it was only in the heavy concentration smoking zone that you had the hazard.

And our concern really was for the flight crews who are essentially operating under, although they are not OSHA rules, that is their workplace. Many cities have now banned smoking in the workplace because of potential hazards. And that is their workplace.

So our concern was flight crews rather than passengers in the nonsmoking zone.

Senator **Kassebaum**. I think your report concludes that if smoking passengers were actually scattered throughout the cabin rather than concentrated in a smoking section, that smoking would not pose as great a health hazard.

Mr. **Halfpenny**. Yes, ma'am.

Senator **Kassebaum**. Isn't it true most of the European carriers do seat smoking and nonsmoking passengers together?

Mr. **Halfpenny**. A lot of them carry smoking on one aisle. One-half of the airplane is a smoking zone and the other half is nonsmoking. In other words, they are split fore and aft, rather than front and rear.

Senator **Kassebaum**. That is interesting.

Did you do any comparative study or are any of the foreign carriers doing any research in this area?

Mr. **Halfpenny**. No; not directly on how to distribute smokers. We did some work on this at Lockheed and concluded that that really was not the way to go because the circulation system was designed crossflow, and so it would mix it up pretty well.

I did talk to some people from Air Canada a couple of days ago who are carrying a series of flights between Toronto and Montreal on what are called Rapid Air—no-smoking flights. Now, that is just about an hour flight. He said the response has been excellent. They have very high response, very high-load factors on the no-smoking flights.

Senator **Kassebaum**. That is very different from, say, a 6-hour flight.

Mr. **Halfpenny**. True.

Senator **Kassebaum**. I would just conclude by noting that I share Senator Inouye's frustration over the lack of meaningful data on this subject. We seem to be reinventing the wheel every time we get involved in a study and a hearing, and we sincerely hope more information will become available. Mr. Halfpenny, you do recommend additional studies, do you not?

Mr. **Halfpenny**. Yes, ma'am.

Senator **Kassebaum**. Well, what will we learn beyond what we should have learned from this?

Mr. **Halfpenny**. Well, we really do not know what the whole total situation is. I would like to refer back to the ozone problem which came up in 1983 when the long-range airplanes were flying, and nobody considered ozone a problem. And the FAA did do some studies and the airlines and the manufacturers did run some tests and found yes, that ozone levels were very high. There was nothing new introduced into airplanes. They have been flying in ozone for years.

But all of a sudden, the exposure became higher because of a new operating environment and higher altitudes and then corrective action was taken.

But I think the area of cabin air quality, not only on airplanes, is really ignored. Most standards for airflow are based upon, as I said earlier, odor sensitivity and some sense of comfort. And there has been little in any closed environment on health, except for the recent EPA and OSHA studies which usually deal with more severe pollutants.

But, yes, I believe that we should do some official data collection, and it should be done well and it would give us a base for evaluating airplane systems.

Senator **KASSEBAUM**. Yes, Senator Inouye.

Senator **INOUYE**. I would like to ask one more question.

I gather that the FAA does have standards relating to carbon monoxide, radiation, and airborne contaminants. But do you have any program in place to enforce or monitor these standards?

Mr. **BEARD**. The CO_2 standard is a design standard to show the capability of ventilation. In the ozone area, we do require the airlines to have the equipment aboard and to maintain that equipment. It is part of our normal surveillance of airline maintenance programs to assure that they do keep that equipment functional.

Senator **INOUYE**. What about airborne contaminants?

Mr. **BEARD**. I do not believe we have any standards in airborne contaminants. So there would be nothing to monitor there.

Senator **INOUYE**. So you rely upon the airlines to make certain that these things are monitored—carbon monoxide, radiation.

Dr. **JORDAN**. We do not have a standard for carbon monoxide. I would like to go back for a moment to Mr. Beard's testimony as to whether the agency has conducted any studies in respect to cabin air quality. We did conduct some studies in 1971 and 1972 in association with the Public Health Service. With respect to those studies, we did measure certain things like carbon monoxide and particulate matter and aldehydes and that sort of thing, principally in reference to the smoking question.

The information that we developed at that point in time—true, things have changed since then—is that there was not a significant problem. Since that time, of course, we have reviewed the literature as it has become available and, up to the present time, have not identified a need for doing further sampling.

We will reconsider that, of course, in association with the NAS study.

Senator **INOUYE**. Thank you very much.

Senator **KASSEBAUM**. Thank you very much. I appreciate, Mr. Beard and Mr. Halfpenny, your testimony—and Dr. Davis and Dr. Jordan.

The second panel is Mr. Phillips, Ms. Deegan, and Mr. Hainline.

Senator **EXON**. Madam Chairman, we are having an important hearing this morning. I do not want to make light of it, but I would like to ask my friend and colleague from Hawaii if it is all right to smoke here in this room.

Senator **KASSEBAUM**. I will defer to Senator Inouye. I assume our airflow here is such that it would be all right.

Senator **EXON**. Thank you, Madam Chairman. I appreciate that thoughtfulness on the part of yourself and my friend.

Senator **KASSEBAUM**. It is a pleasure to welcome our second panel: Mr. Gabriel Phillips, who is executive vice president of the Air Transport Association; Ms. Tulinda Deegan, vice president, Regional Airline Association; and Mr. Bernard Hainline, chief engineer, Airframe Systems Technology.

Mr. Phillips.

STATEMENTS OF GABRIEL PHILLIPS, EXECUTIVE VICE PRESIDENT, AIR TRANSPORT ASSOCIATION; TULINDA DEEGAN, VICE PRESIDENT, REGIONAL AIRLINE ASSOCIATION; AND BERNARD C. HAINLINE, CHIEF ENGINEER, AIRFRAME SYSTEMS TECHNOLOGY, BOEING COMMERCIAL AIRPLANE CO.

Mr. PHILLIPS. Thank you, Madam Chairman. My name is Gabriel Phillips. I have a statement, Madam Chairman, that is more complete. I will just summarize that statement and hope that you would include the whole statement in the record.

Senator KASSEBAUM. Thank you.

Mr. PHILLIPS. My name is Gabriel Phillips, executive vice president, Administration and Industry Programs for the Air Transport Association. On behalf of our member airlines, I wish to express appreciation for the opportunity to present our views on the Report on Airliner Cabin Air Quality recently completed by the National Academy of Sciences.

Public Law 98-466 directed the Department of Transportation to engage the NAS to perform a study of airline cabin air quality and we are, of course, addressing the report and conclusions of that study.

By our count, the report contains 42 recommendations for action by Congress, the FAA, the airlines, the airplane manufacturers, medical community, aircraft crew members, and/or the public at large. In addition, a number of conclusions are made that some areas of concern require no action.

Since the study has been available for only a short time, we are continuing to evaluate the NAS conclusions and recommendations and we do have some preliminary conclusions, however, on some of their findings.

With respect to the several we are able to address, we concur with or accept the NAS recommendations on humidification, pressurization and flammability testing. We agree only in part or disagree with NAS recommendations on ozone radiation, and smoke and fume removal.

On the recommended ban on smoking on board commercial aircraft on domestic flights, ATA takes no stand on the medical basis of the recommendation, but has several concerns about it. First, the scientific data about the effects of indoor pollution and intelligent abatement alternatives is scarce. If Congress decides to enact legislation to ban smoking in advance of additional study, no basis has been established thus far to discriminate among types of public places, individual companies, or industries.

There is no reason to single out aviation as an industry requiring controls, and legislation to ban smoking on flights of certain duration is particularly bad public policy. The study has not adequately addressed the hazards of clandestine smoking if a ban on smoking was decreed.

Many of the NAS recommendations involve potential rulemaking activities of the FAA and we will be happy to participate in any technical investigations and/or regulatory developments the FAA may undertake in these matters. We understand the FAA will be reporting to Congress soon on its reaction to the NAS recommendations and we look forward to a review of that report.

I will be happy to answer questions.

[The statement and questions and answers follow:]

STATEMENT OF THE AIR TRANSPORT ASSOCIATION

My name is Gabriel Phillips, Executive Vice President, Administration and Industry Programs for the Air Transport Association. On behalf of our member airlines, I wish to express our appreciation for the opportunity to present our views on the Report on Airliner Cabin Air Quality recently completed by the National Academy of Sciences (NAS).

Public Law 98-466 directed the Department of Transportation to engage the NAS to perform a study of airliner cabin air quality. The study was to encompass: the quantity and quality of air on board; comparison of standards with non-aviation environments; quantity and quality of humidification; contamination limits; cosmic radiation exposure; emergency breathing equipment; fire detection and extinguishment; smoke and fume removal; safe pressurization; and the collection and dissemination of medical data related to commercial air travel. By our count the report contains 42 recommendations for action by Congress, FAA, airlines, airplane manufacturers, the medical community, aircraft crewmembers and/or the public at large. In addition, a number of conclusions are made that some areas of concern require no action. The following are ATA comments on several of the NAS conclusions and recommendations; the industry continues its evaluation of the others.

HUMIDIFICATION

NAS concluded that the health risks associated with clean, dry air appear quite low and probably do not justify the cost and potential microbiologic complications that would attend installation of active humidification systems in aircraft. This conclusion supports airline experience and analysis, and we concur.

OZONE

The NAS Committee suggested that FAA: (a) carry out a carefully designed program to ensure that ozone concentrations comply with DOT regulations; (b) establish policies for periodic removal and testing of catalytic converters so that the effective life of these units can be established; and (c) systematically measure ozone and other parameters on a representative sample of routine commercial flights.

The airlines do not oppose any reasonable effort of the FAA to ensure that regulations regarding cabin ozone—or any other regulation for that matter—are being followed. Part 121 of the Federal Air Regulations permits several alternative methods of establishing reasonable assurance that ozone concentration limits are not exceeded, and some airlines may use one method while other airlines may use other methods. Those using catalytic converter have progressed through a learning curve which resulted in a program of periodic replacement to assure that ozone conversion efficiency is maintained at a high level in service. More work in this area by the FAA may be redundant.

During the development of charcoal filters and catalytic converters for ozone abatement during the late 1970s and early 1980s, a considerable amount of data was collected on naturally occurring ozone levels and the unaided ozone destruction that takes place in airline cabins. While we understand the Committee would like to expand the data base for purposes of scientific rigor, we feel that designers of ozone converters and aircraft environmental control systems have an adequate picture of ozone behavior without adding more expensive monitoring activities.

RADIATION

NAS recommends that flight crew and cabin crew members be advised of potential radiation exposure and of the particular risks associated with pregnancy. It also recommends FAA consider regulating the exposure of pregnant crewmembers. FAA has recently completed a review of this issue—following NAS's completion of its study but preceding its publication—which endorsed the aspect of informing crews of radiation hazards, and FAA plans to issue advisory material to this end. FAA concluded, that crewmembers for the most part have substantial control over the routes they fly and can thus limit radiation exposure. This is a practical approach, and avoids resurrecting the civil rights conflict over discrimination against pregnant employees.

SMOKE AND FUME REMOVAL

The Committee recommends that, in the event of a cabin fire, all available air packs be turned to full volume and that recirculation, if available, should be turned off. It also recommends that current emergency procedures calling for depressurization be discontinued. Further, the Committee recommends these changes be verified by modeling studies and confirmatory live testing as soon as possible.

To us, these recommendations sound like a "shoot-now, ask-questions-later" approach. If NAS has any doubts about its recommendation to change the pressurization and ventilation procedures, it should recommend the study precede any action. Otherwise, the Committee members and/or the Federal Government would be injecting themselves into the product liability picture as potential defendants. We doubt that this was intended. Clearly, the designers and manufacturers of the environmental control systems must have the final word on how the systems should be operated in an emergency.

PRESSURIZATION

The NAS concluded that current pressurization criteria and regulations are generally adequate to protect the traveling public, but the medical profession should use a more efficient system to warn vulnerable people of any health hazards that should be considered when they travel by air. This conclusion is in keeping with the airline view that personal physicians are better equipped than airline agents to warn patients of any unique risks that air travel might represent to them.

FLAMMABILITY TESTING

NAS recommends that manufacturers should be encouraged to initiate or support continuing research in cabin interior materials development. The manufacturers, as well as ATA airlines, strongly support materials research and we work continuously with FAA and NASA research laboratories to advance this technology. Moreover, we have a major alternative proposal for a more effective flammability testing methodology which the FAA has published for comment.

THE SMOKING ISSUE

The Report has received wide publicity for its recommendation to totally ban smoking on board commercial aircraft on domestic flights. As explained in the following comments, the ATA takes no stand on the medical basis of this recommendation, but states several concerns related to it.

While many problems related to outdoor pollution have been investigated and regulated for a number of years, concern about indoor pollution—e.g., environmental tobacco smoke, radon gas, and gases emitted by synthetic fabrics in home furnishings—has only recently come to the fore. The science of analyzing this form of pollution is still developing, and data to point the way toward intelligent abatement alternatives is scarce. NAS's Report time and again decries the paucity of solid data upon which to found conclusions and recommendations.[1] The ultimate determination of whether or not air impurities inside of airplanes, shops, buses, auditoriums and other public places—as well as our homes—are deleterious to our health must await definitive determination by the medical and scientific communities. If, however, Congress decides to enact legislation to ban smoking in advance of any such definitive determination, no basis has been established to discriminate among types of public places, individual companies or industries.

Airline cabins, while different in some respects from other indoor settings, are not sufficiently unique to justify isolated treatment. Passengers sit for limited periods in settings not unlike restaurants and other transit modes, and even crewmembers who are exposed for greater periods than passengers spend only about 20 hours per week onboard airplanes. Therefore, there is no reason to single out aviation as an industry requiring controls.

One proposal that has been debated in years past before the Civil Aeronautics Board, and that has been reproposed in legislation recently introduced in the House, is a ban on smoking on flights of certain duration, such as flights of less than 2 hours time. We are opposed to this concept which at worst discriminates against some airline companies and certainly creates an administrative nightmare over the question of exactly what constitutes a 2-hour flight. We feel that any further regulation of smoking on aircraft must be uniformly applied to all domestic commercial flights in the United States.

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[1] E.g., pp. vii, 3, 5, 7, 11, 15, 17, 21.

As implied earlier, we have concerns about the NAS study. First, the NAS Committee acknowledged that its recommendations relied heavily on two factors to which outsiders have not had access: (a) preliminary results of a separate National Research Council study on passive tobacco smoking, which will not be available to the public for independent expert scrutiny for another month or more, and (b) a computer model of air circulation in aircraft cabins designed at the behest of the Committee during its investigation and not yet validated by the aviation industry.

Further, notwithstanding NRC's belief that smoke detectors and fire extinguishers reduce the hazards of clandestine smoking in restrooms, we think the FAA and other aviation experts need to examine this issue more closely before action is taken. Since there was no airline representation on the NRC Committee, we are concerned that there may be other operational factors not considered in the recommendation. In sum, in the month since release of the NAS document, we have not had adequate opportunity or factual material to assess all the issues involved in this recommendation to ban smoking.

CONCLUSION

Many of the NAS recommendations involve potential rulemaking activities of the FAA, and we will be happy to participate in any technical investigations and/or regulatory developments the FAA may undertake in these matters. We understand the FAA will be reporting to Congress soon on its reactions to the NAS recommendations and we look forward to a review of that report.

Questions of Senator Inouye and the Answers

Question 1. What does the ATA feel about giving a federal agency the authority over health issues in the airline cabin environment?

Which agency do you feel is best qualified for the job?

Answer. FAA's statutory charter to assure safety of flight is far-reaching, and it has been extended to numerous health issues, e.g., cabin ozone levels and medical kits. No further authority is required.

Question 2. A recurring theme in the NAS study was the lack of data available, especially data obtained through actual measurements on routine commercial flights. It is my understanding that the airline industry was unable to reach an arrangement for such testing during the course of the NAS study.

Would the airline industry be willing to assist the FAA or an independent entity in installing a program to collect such data on a regular basis?

Answer. At the beginning of the NAS study, ATA urged the NAS to undertake the requisite testing to answer the air quality concerns once and forever. The test protocol advanced by NAS to the airlines was, by NAS' own admission, too small to affirmatively decide any of the concerns positively or negatively. Airline reluctance to bear the inconvenience and costs of those tests therefore is understandable.

The FAA, NASA, airplane manufacturers and airlines are frequent partners in tests involving various aviation phenomena. The cabin ozone matter is an example, and there is no reason to believe that other cabin environment concerns, if adequately founded, cannot be similarly investigated.

Question 3. What is the airline industry policy with regard to the operation of the air packs?

Given the current lack of regulations regarding this area, what is this policy based on?

What do you estimate the ventilation rate per passenger is on a fully loaded aircraft with one air pack going?

What would be the cost of running all air packs at maximal airflow, as recommended by the NAS?

Would your members consider such a policy.

Answer. This is essentially the same question asked by the Subcommittee in an earlier interrogatory[1]. While it is possible that some operators may have adjusted their procedures since our previous survey, we do not believe that the changes are of a magnitude warranting a new canvass of members.

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[1] Hearing before the Subcommittee on Aviation of the Committee on Commerce, Science and Transportation, U.S. Senate, on S. 1770, Airliner Cabin Safety and Health Standards, May 20, 1982, p. 64.

Aircraft pack operation policy is based on several factors—the excess ventilation capability of a given design above regulatory requirements, seating configurations, route structure, passenger load, perceived costs of pack operation, and others. Some operators do not reduce air flow, and others reduce flow only when passenger loads are reduced; thus in practice there may only be occasions when fully loaded aircraft are operated with only one pack going, and the attached data indicates that the worst configuration still provides about 7 cubic feet per minute per passenger. The overall average is three times that amount (NAS Report, page 53).

The exact cost of modifying policy to use full ventilation at all times regardless of passenger load has not been determined. The current airline policies are responsive to passenger needs and accommodate as well as possible the conflicting desires of smokers and non-smokers, and there are no planned changes at this time.

Question 4. From your testimony it is clear you do not consider the ban on cigarettes to be warranted. Indeed you state that the cabin environment is not adequately different than other transit modes to justify such isolated treatment.

Do you see any available alternatives to the cigarette ban in the effort to improve the quality of airline cabin air?

Would increased ventilation serve this purpose?

Answer. The ATA takes no stand on the medical aspects of the NAS recommendation to ban smoking. As to other aspects, the current practices of segregating smokers and non-smokers and banning cigars and pipes appear to be the best compromise. Significantly increasing the ventilation, as by the addition of extra packs, is not a viable option, a conclusion adopted by the NAS (Report, page 151).

Question 5. The NAS Report states that current pressurization standards and conditions do not pose a problem, as rarely do airplanes go above the 8,000 level.

Are there any warning devices in the cabin to inform the crew that the pressurization has risen above this level?

If so, should not these warnings go off at 8,000 feet rather than levels much higher than the accepted levels?

Answer. The nature of pressurization problems, infrequent as they are, is such that cabin altitude quickly increases to the point at which automatic deployment of supplemental oxygen is provided to passengers and crew. This is followed by an emergency descent executed by the flight crew unless for some reason the crew determines this maneuver to be unnecessary or undesirable. Considering these safeguards additional warnings would be of questionable benefit.

Question 6. I have been informed that the ATA in response to a 1980 petition for rulemaking stated that humidification ranged anywhere from 5 percent to 59 percent during flight.

What is the industry policy regarding humidification levels?

We are informed that a 59 percent humidity level at cruising altitude corresponds to about 3 cubic feet per minute per passenger for a full load: an extremely low ventilation rate. Is this correct, if so do you feel it is adequate?

Answer. While cabin humidity levels are sometimes less and sometimes more than ideal from the standpoint of comfort, there is no associated health hazard. NAS concludes that associated health risks appear quite low (Report, page 165). Humidity levels are not controlled on airline aircraft, but there are ample sources of liquids on board to replenish normal fluid loss by passengers and crew. Increased humidification could introduce problems far more serious than personal discomfort, e.g., microbiologic complications, as the NAS report points out (Report, page 165).

We cannot confirm that 59 percent humidity necessarily corresponds to any particular ventilation rate. Humidity levels on a given flight, begin at the ground level values at the departure point, which may vary from 0 to 100 percent, and near the end of a long flight may stabilize in the 5-10 percent range.

Question 7. What would it cost the airlines to provide emergency breathing equipment to all cabin crew and/or all passengers?

Considering the NAS finding that many potentially viable models are now available, and that other foreign nations such as the United Kingdom and Scandinavia are now considering these devices for all passengers, do you consider this a viable and useful policy?

What protection is there currently for passengers in the event of smoke and lethal fumes in the cabin?

Answer. There is no way to predict the costs of providing emergency breathing equipment for passengers. Cockpit crewmembers already have such equipment and a pending FAA rulemaking action addresses availability of similar apparatus for flight attendants. Previous studies have recognized the serious possibilities that such devices could increase loss of life due to delays caused by passengers trying to put them on rather than quickly trying to evacuate the aircraft.

We encourage periodic reviews of technology advancements, and it is our understanding that FAA has such a review under way. The NAS report, Chapter 4, summarizes current aircraft capabilities for smoke and fume removal.

Question 8. What procedures do the airlines currently practice in the case of in-flight fires?

Would your members be willing to include a description of these measures in the pre-flight passenger safety briefings?

If not, why not.

Answer. The proper response to an in-flight fire is for the crewmembers to extinguish the fire as soon as possible, if possible, and land the aircraft as soon thereafter as possible if significant damage occurs or if the fire can't be extinguished. The items of information needed by passengers are (a) instructions not to smoke in unauthorized areas or at unauthorized times, and (b) instructions for evacuation on the ground, both of which are already addressed. Other more detailed instructions on specific inflight emergencies are disseminated by the crew as circumstances dictate.

Question 9. On page 61 of the NAS study there is a comparison of fuel required, in gallons per hour per passenger seat, versus outside air in cubic feet per minute per passenger (cfmp). On page 60, the study notes that the current price of aviation fuel is between 76 and 86 cents per gallon. Based on this data, it would appear that the cost for fresh air ventilation, according to Boeing estimates for 727's and 747's, is approximately 11 cents per passenger seat per hour at five cfmp. An additional five cfmp costs an extra two cents. To have 20 cfmp, it would cost a total of 26 cents per passenger seat per hour, while 35 cfmp would cost 43 cents. Do these figures appear correct?

If so, it certainly seems that the cost for providing fresh air for the individual traveler is minimal and could easily be passed along to the customer if the airlines could not absorb it. Do you feel the benefits of this additional fresh air are worth the minimal extra cost? Please comment.

Answer. The NAS report at the referenced pages is based on data supplied by the Aerospace Industries Association, and we suggest that the AIA be contacted directly for verification of the accuracy of that data and these interpretations by the Aviation Subcommittee. We believe it is reasonable for operators to manage the cabin environment to the extent the aircraft design and regulatory constraints allow while responding to passenger comfort needs. When passenger loads are low, ventilation needs are less than when loads are high, and even in the case of reduced loads, passengers and cabin crew can have the cockpit crew increase airflow if the air seems stale. Due to the low level of passenger complaints, less than one per million passengers according to CAB/DOT consumer complaint data, we believe it reasonable to conclude that current practices are adequate.

Question 10. In the ATA's testimony on September 19th, you identified 42 distinct points and recommendations in the NAS study. Please specify in as much detail as possible what these points are.

Answer. These points are identified in Exhibit A, attached hereto.

Question 11. Information provided by NASA suggests that skin exposure levels during flight may reach 8,000 millirems per hour. This compares to a few hundred millirems for chest and dental x rays. We understand in the radiology profession that women in their first trimester of pregnancy should have no x rays at all. Indeed there are signs posted in x ray rooms informing women to notify the doctor or technician if they suspect they are pregnant. If the level of 8,000 millirems per hour during a cross-country flight is equivalent to 600 x rays, would it not seem appropriate for the airlines to warn the traveling public, including the cabin crew and especially pregnant women, of the possible dangers of such exposure?

Answer. Radiation exposure varies with flight altitude, and it is not clear here whether NASA's information relates to commercial aviation or to space flight. As documented in Chapter 5 of the NAS report, average dose per cabin crew member has been estimated at 160 millirems per year, a level comfortably below any level of concern for the average person.

EXHIBIT A

Suggestions, Conclusions and Recommendations of The National Academy of Sciences Committee on Airliner Cabin Air Quality,[1] an ATA Analysis

The findings of the Committee on Airliner Cabin Air Quality are summarized below, following the outline of objectives that appears in the statute.[2]

Section 1.(a). The study shall determine whether industry standards, practices and FARs are nondiscriminatory and in parity with non-aviation environments with respect to air quality for passengers and crew.

- No findings specifically addressed discrimination. (Flight attendants have shown concern that the higher ventilation rates in cockpits reflects a discrimination in favor of pilots and against cabin crew. The Report[1] - at p.43, e.g. - explains that the higher cockpit rates are due to larger solar and electronic cooling loads compared to cabin requirements.)

- The Committee found that ventilation standards that have been set to avoid irritation by environmental tobacco smoke (ETS) in buildings are not met by standard aircraft practices (Report, p.150). Increasing the aircraft ventilation for the smoking zone to come into compliance with ASHRAE guidelines[3] is not technically feasible on existing aircraft (p.151). A return to the random distribution of smokers throughout the cabin would decrease the peak concentrations of contaminants, but the Committee feels that this probably would be unacceptable to a majority of the traveling public (p.151).

Section 1.(b). The study shall focus on health and safety aspects of -

(1) Quantity of fresh air and overall quality of air onboard.

Infections.

- R1 If the risk of infection is to be minimized, the amount of outside air supplied to each passenger during flight should be maximized (p.160). The Committee recommends that maximal airflow be used with full passenger complements to decrease the potential for microbial exposure (p.7).

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[1] The Airline Cabin Environment, Air Quality and Safety. National Academy Press, Washington, D. C. 1986.

[2] From Senate Bill 197, enacted as Public Law 98-466.

[3] American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., ASHRAE 62-1981.

- R2 Because of the heavy potential risk of spread of infectious disease in aircraft on the ground with no outside ventilation, the Committee recommends that no aircraft with passengers on board remain on the ground without operational forced ventilation for longer than 30 minutes (p.159). If forced ventilation cannot be initiated within 30 minutes, passengers should be returned to the terminal (p.159). A regulation to this effect should be established (p.7).

- R3 Physicians should be reminded of the rules stating that infectious passengers may not travel on commercial airliners (p.160).

- R4 Pathogenic microorganisms should never be transported in passenger-carrying aircraft and any nonpathogenic microorganisms in culture should be packed so as to eliminate any possibility of escape (p.154).

- R5 Recirculated air should be filtered to remove particles larger than 2-3 microns to reduce microbial aerosol concentrations (p.7).

- R6 Every feasible effort should be made to ensure that wet surfaces are prevented or scrupulously cleaned routinely, to prevent structural contamination (p.160).

- R7 Cargo compartments should be kept free of animal excrement, as well as arthropod pests (p.160).

ETS.

- R8 The Committee concludes that there is a positive association between lung cancer and chronic exposure to ETS (p.145). The cabin crew are chronically exposed to substantial ETS concentration (p.147). The potential health effects of ETS on non-smokers are of more concern that the effects of withdrawal on smokers, and more people are at risk, therefore the current smoking ban applicable to small aircraft should be extended to all domestic commercial flights (p.149).

- R9 Those who suffer withdrawal symptoms should discuss with a doctor the use of nicotine substitutes to alleviate the discomfort (p.149).

(2) Quantity and quality of humidification

- Health risks associated with clean, dry air appear quite low and probably do not justify the cost and potential microbiologic complications that would attend installation of active humidification systems in aircraft (p.165).

(3) Environmental conditions and contamination limits, including radiation.

Ozone.

R10 . The Committee suggests that FAA carry out a carefully designed program to ensure that ozone concentrations comply with DOT regulations (p.5, 119).

R11 . It is suggested that FAA establish policies for periodic removal and testing of catalytic converters so that the effective life of these units can be established (p.119).

Carbon Dioxide.

R12 . FAA should review the cabin CO_2 standard for possible revision in light of recent scientific findings and standards adopted by ACGIH[4] (p.4, 168).

Carbon Monoxide and Respirable Suspended Particulates

R13 . The Committee strongly recommends that, so long as smoking is permitted on airplanes, the Congress mandate a program to monitor onboard CO and RSP (p.218).

Radiation.

R14 . Airlines should investigate the policy options for informing female flight attendants about the possible risk involved in flying during pregnancy (p.130). Also, FAA should require airlines to provide information to flight attendants about radiation exposure, and should consider rulemaking that restricts exposure of pregnant flight crew and cabin crew members (p.9).

R15 . FAA and EPA should investigate in-flight cosmic radiation exposures of crew members, particularly exposures during solar flares (p.130), through the use of a statistical sample of full-time employees (p.9). FAA should measure exposure to cosmic rays on a representative number of current flights and repeat this on a regular basis, and should periodically review flight routes and altitudes to assess their implications for exposure to cosmic radiation (p.218).

R16 . A special effort should be made to alert the medical profession of the hazards to groups that might be at increased risk, such as pregnant women and patients receiving particular medical therapy (p.218).

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[4] American Conference of Governmental Industrial Hygienists, 1984.

- R17 Those who live at high altitudes should perhaps avoid further chronic exposure to cosmic rays in high-altitude flights (p.218).

(4) Emergency breathing equipment.

- R18 FAA should re-evaluate smoke hoods or special breathing devices for passenger use (p.105, 108), in case of in-flight and postcrash fires (p.11).
- R19 The Committee recommends that FAA review the proposed rule on protective breathing devices for crew members to ascertain the desirability of supplying such equipment for all crew members, rather than limiting it to the persons expected to be involved in firefighting (p.11).
- R20 The Committee suggests further evaluation of the potential of emergency breathing equipment for all cabin crew members to improve safe and expeditious evacuation of passengers in fire emergencies (p.11).

(5) Detecting and extinguishing fires, and removal of smoke and fumes.

Fire detection/extinguishment

- No conclusions or recommendations are documented with respect to detection of fires and methods of extinguishment, although fire prevention is a concern (recommended ban on smoking, further work on material flammability, etc.) as well as smoke removal and passenger briefings.

Smoke and fume removal

- R21 Smoke and toxic fumes are the principal problem in noncrash aircraft fires (p.99). The Committee strongly recommends that cabin-fire instructional material emphasize the need to turn on all available air packs to full volume if a cabin fire or smoke is present (p.100).
- R22 If recirculation is available, it should be turned off (p.100, 108).
- R23 The Committee noted that current emergency procedures for smoke removal recommend that the cabin be depressurized to 10,000 feet. This procedure is ineffective and should be discontinued (p.10).
- R24 FAA should review current airline procedures for cabin fire and smoke emergencies for all aircraft in U.S. commercial service (p.108).

R25 . Air contamination modeling studies and confirmatory live testing in aircraft should be performed as soon as possible, by properly constituted FAA-industry teams, to determine conclusively the advantages of turning on all packs to full volume when there is an in-flight fire (p.108) and to develop detailed procedures for optimal crew management of pressurization, ventilation and exhaust systems (p.100).

R26 . Detailed procedures should also be developed for engine and air pack shutdown and for use of an APU after landing to continue to provide ventilation and prevent buildup of heat and flammable fumes that could produce flashover during evacuation (p.101).

(6) Safe pressurization and dissemination of related medical information to physicians and the public.

. The Committee concluded that current pressurization criteria and regulations are generally adequate to protect the traveling public (p.8).

R27 . A number of medical associations publish guidelines for physicians to use in advising patients about air travel (p.207). However, the medical profession should use a more efficient system to warn those with medical conditions sensitive to pressure changes that there might be some hazard to their health in air travel (p.8).

. Carefully worded messages could be made available at ticket counters or through other ticket vendors (p.167).

R28 . Cabin crew members should be advised of symptoms of those with medical conditions sensitive to pressure changes and the procedures available to alleviate them (p.166).

(7) Collection and dissemination of medical, environmental and operational statistics.

Medical

R29 . FAA's Accident/Incident Data System (AIDS), in which limited health data on passenger and crew are collected, requires considerably more effort by FAA to make it an effective source (p.206). The Committee suggests consideration be given to adapting AIDS and/or Service Difficulty Reports to include collection of data relevant to the assessment of cabin air quality (p.216).

R30 . Appropriately designed studies of selected health effects among crew members should be performed (p.220).

- R31 The Committee recommends studies to examine rates of spontaneous abortion and birth defects among cabin crew members (p.221), as well as careful measurements of exposure. A feasibility study should be undertaken to determine whether a control group of non-flying employees could be established for comparisons with cabin crews for this purpose (p.221).

- R32 Chronic obstructive pulmonary disorders and pulmonary disability should be identified, using both flow-loop volume and forced expiratory volume tests, among crew members and perhaps among selected passengers (p.221). Pulmonary function testing should be conducted before and after exposure to airliner cabin air (p.222).

- R33 A feasibility study should be conducted to determine if incidents of myocardial infarction in or near airports, compared to those experienced in flight, would yield a valid indication of the effects of flight (p.222).

Environmental

- R34 The committee recommends that FAA establish a program for the systematic measurement, by unbiased independent groups, of the concentrations of carbon monoxide, respirable suspended particulates, microbial aerosols and ozone, and of ventilation rate, cabin pressures and cosmic radiation on a representative sample of routine commercial flights (p.4, 11, 159, 167, 214, 218).

- R35 Congress should provide funds for studies to measure volumetric bioaerosol concentrations in aircraft and associated variables - temperature, humidity, ventilation rate, filtration modes and number of passengers - and bioaerosol concentrations in the intake air of aircraft on the ground (p.219).

- R36 The odor characteristics of ETS in the airliner cabin need to be studied to determine how low humidity and other environmental conditions affect discomfort related to odor sensitivity (p.144).

- R37 Actual ventilation rates should be measured under routine flight conditions in all types of commercial aircraft, and if results of an initial study indicate problems with variations in flow rates and pollutant concentrations, continual monitoring should be instituted (p.217).

Operating Data

- R38 The Committee recommends that FAA, in conjunction with the medical/scientific community, establish a clear protocol for reporting data on the use of emergency medical kits in such a way as to permit comparison of onboard incidents with those in other settings (p.12, 223).

(8) Preflight and inflight health and safety instructions.

R39 . The Committee recommends that FAA require that information on proper response to fire emergencies be included in oral and written passenger safety information (p.10, 109).

R40 . FAA or industry should consider conducting empirical research to examine passenger response to safety instructions under routine and emergency conditions (p.10). Consideration should be given to conducting quizzes during flight to determine retention of key information from safety briefings (p.84).

. A suggestion for improving retention is an on demand video safety presentation available in waiting lounges (p.83).

(9) Comparison of U.S. standards with foreign standards.

. The Committee found that differences do not appear significant, and no further effort to align U.S. and foreign standards is warranted (p.11).

Miscellaneous findings of the Committee

R41 . FAA has claimed regulatory jurisdiction over the cabin as a workplace (p.205), however the health effects associated with air travel are not specifically assigned to a federal agency for oversight and control. Congress should remedy this (p.3).

R42 . The FAA program on flammability testing is excellent, but manufacturers should be strongly encouraged to initiate or support continuing research in cabin interior materials development (p.10, 97, 108).

. It has not been possible for the Committee to determine the facts concerning the effectiveness and adequacy of FAA enforcement and inspections relating to cabin safety and air quality (p.79).

Senator KASSEBAUM. Thank you.

Ms. Deegan.

Ms. DEEGAN. I am Tulinda Deegan, vice president of the Regional Airline Association. My primary area of responsibilities are on the consumer industry areas in transportation of the regional airline industry.

I appreciate the opportunity to comment on the NAS study on behalf of the regional airlines. We support and concur with the NAS finding, of course, on page 30 that the study does not attempt to address cabin air quality on regional aircraft because "ventilation rates on small aircraft are generally much higher than on larger aircraft."

That does not mean that we do not want to continue to ensure that the cabin air quality on regional aircraft meets all the health and safety needs of our passengers, too. Therefore, we would like to take a few minutes and look at applying some of the conclusions that were introduced in the report to the regional airline fleet.

A brief profile of the regional airline industry: Again, we fly less than 60-seat aircraft and the typical regional airline flies a 19-passenger aircraft, 173 miles, on a 45-minute flight.

NAS states that the exchange of outside air, fresh outside with the cabin air is a key factor in determining cabin air quality. Sixty-six percent of our fleet is not pressurized. By definition, that means that the outside air and the inside air are at the same pressure level. Therefore, there must be an exchange of air between outside and inside to keep the pressures the same.

As a result, we have a very free exchange of outside air with the air onboard the aircraft. Further, our frequent takeoffs and landings on the typical airline operation requires that the cabin doors be opened and the cabin ventilated on a much more frequent basis. Of course, all of these openings are on land, not in the air. But we pull into an airport; again, it is a 45-minute flight. They stop, turn around, 20 minutes, open the doors, people in and out, and in the smaller cabin there is a greater opportunity for the air to ventilate.

Both of these observations on the part of RAA support the NAS statement that smaller aircraft have higher cabin air ventilation.

NAS also explored the potential impact of ozone in the cabin environment. Regional aircraft do not fly at the altitudes or latitudes where high levels of ozone are present. RAA supports the NAS recommendation that flight crews and cabin crew members be advised of any potential sources of high level of radiation.

NAS identified pollutants associated with the preparation of food as a potential source of cabin air contamination. Regional airlines do not prepare food in flight. All snacks are prepared on the ground and are merely distributed to the passengers while airborne.

Finally, the NAS study has received a great deal of publicity for its recommendations that smoking of all tobacco products aboard aircraft be banned. As the committee well knows, 2 years ago the Civil Aeronautics Board decided to ban all smoking on aircraft seating less than 30 passengers.

On June 20, 1984, the Board amended part 252 of its economic regulations as follows:

Carriers shall adopt and enforce rules prohibiting the smoking of tobacco on aircraft designed to have passenger capacities of less than 30 seats.

Recently, RAA conducted a telephone survey of our members who operate aircraft in the 30- to 60-seat category. Currently, none of them have banned smoking completely, but most do ban smoking of the flight crew and the cabin crew. RAA takes no position on the medical aspects of smoking aboard aircraft.

Finally, the NAS looked at a number of safety issues, particularly focusing on the effects of fire and smoke and the ability of survivors to evacuate a survivable crash. I just wanted to attach the summary of the Federal Air Regulations that address these two areas, and show how they do apply to the regional airline industry.

Specifically, these regulations cover airplane fire detection, the lavatory smoke detectors, emergency medical kits, flammable requirements for the aircraft seat cushions, and the floor proximity emergency escape path marking.

In conclusion, the NAS report contains many recommendations that require further study and action by Congress, FAA, the medical community, airlines, and aircraft manufacturers. The Regional Airline Association looks to working through all of these studies and thank you for the opportunity to present our views.

Senator **KASSEBAUM**. Thank you very much.

Mr. Hainline.

Mr. **HAINLINE**. Madam Chairman and Senators Inouye and Exon, I am Bernard Hainline, chief engineer for Airframe Systems Technology for the Boeing Commercial Airplane Co. I am appearing here today on behalf of the Aerospace Industries Association of America.

The AIA is a trade association which represents the Nation's major manufacturers or aircraft, aircraft engines, and related components and equipment.

I would like to commend the Aviation Subcommittee for promoting this study by the National Research Council Committee on Airliner Cabin Air Quality. The NRC committee, consisting of a group of independent professionals, have summarized a large amount and a wide range of controversial and technically different aspects of cabin air quality and safety into a single document.

The AIA supported the study by providing airliner data and hosting a visit to an airplane development and manufacturing facility. The report accurately reflects the data provided by the AIA. I will address a few aspects of the report.

On the subject of materials testing and selection, the NRC committee recommended that the AIA fund and initiate a program to develop a more fire-resistant set of materials from which to fabricate fully functional materials for aircraft. This activity has actually been implemented for many years.

Manufacturers of airplane interiors have singly and jointly worked with manufacturers of materials to develop more fire resistant cabin furnishings. The criteria used by the industry to guide the development of these materials have been substantially beyond the existing requirements in the Federal Aviation Regulations.

Tests involving flammability and smoke and toxic gas generation are being used. Improved materials have been progressively introduced into production on new airplane models. Improved materials have also been applied to older airplanes.

On the subject of removal of toxic fumes generated by onboard fires, the FAA has an active research program to develop improved methods for controlling cabin smoke. The AIA is cooperating in this activity.

The NRC committee apparently misunderstood current emergency procedures for smoke removal where it is recommended that the cabin be depressurized to 10,000 feet. They felt that this procedure was ineffective and recommended that it be discontinued.

The airframe manufacturers have run many tests, both ground and flight, to determine the best methods of clearing smoke from the cockpit and cabin on each new model airplane. These tests are the basis of part of the certification activities. In case of smoke it is standard procedure to shut off all recirculation systems first. Depressurizing the cabin to 10,000 feet is not done to starve a fire. On some airplanes where this procedure is used, the airplane is descended to 10,000 feet and depressurized so appropriate doors can be partially opened. This procedure provides air currents that have been shown by in-flight testing to be effective in removing smoke from the cockpit and cabin.

On other airplanes, the best procedure is to remain fully pressurized and allow the air-conditioning system to clear the smoke. In each case the procedure has been developed, proven and is part of the cockpit smoke clearance procedures for that particular model airplane.

Usually for smoke clearing, all air-conditioning packs are turned on. However, this may tend to make the fires burn more vigorously. If the smoke is light and not causing physical distress, it may be better to leave the air-conditioning flow low. This is a decision the crew should make, depending on the circumstances.

On the subject of cabin air quality: Today's airliners provide a cabin environment that protects the health and safety of passengers by meeting or exceeding existing regulations that emphasize safety. Extending existing regulations to encompass improved cabin air quality is a complex technical issue. Redefined regulations must be supported by appropriate tests, empirical data and analysis.

For example, use of the quality of the outside air as a prime variable in the assessment of air quality within an airliner may not be appropriate. Air quality assessment should consider ventilation effectiveness. Ventilation effectiveness is indicative of the quality of air that is available for breathing by individual occupants, rather than a ratio of outside air within a compartment which may not be usable in breathing space.

The AIA would support any effort to improve airliner air quality standards where Government, aircraft industry, and the airlines participate.

Thank you for this opportunity to appear before you.

[The questions and answers follow:]

QUESTIONS OF SENATOR INOUYE AND THE ANSWERS

Question 1. Currently, what levels of airflow are the aircraft ventilation systems built to provide?

What are these standards based on?

Would direction from the FAA be useful in terms of knowing what airflow rates to gear aircraft ventilation systems to provide?

What fresh airflow rates are currently provided on a fully loaded 747 or L-1011 at the following air pack operations: one pack auto low, two packs auto low, one pack auto high and one pack auto low, two packs auto high, three packs auto low, and three packs auto high?

Answer. Table 2-1 of the NRC report gives levels of airflow provided and are shown below:

TABLE 2-1.—EFFECT OF FLOW OPTIONS AND SEATING DENSITY ON PASSENGER VENTILATION RATE[1]

Aircraft model and number of passengers	ECU operation		Outside air per passenger, cfm		
	Number	Flow schedule	First class	Overall average[2]	Economy class
DC-10:					
290	3	High	—	18.5	
290	2	Low	—	6.9	—
274	3	High	—	21.0	—
274	2	Low	—	8.4	—
L-1011-1					
279	3	Normal	28.7	—	19.5
279	2	Normal	17.3	—	11.6
L-1011-500					
235	3	Normal	51.0	—	18.6
235	2	Normal	30.5	—	11.2
B-747-200					
381	3	Normal	40.4	—	17.1
381	2	Normal	26.5	—	8.5
300 [3]	3	50 percent	11.4	—	10.6
265 [3]	2	50 percent	12.7	—	10.6
B-767-200					
217	2	Normal	10.0	—	9.9
217	2	Optional filters installed	[4] 20.0	—	[4] 19.8

[1] Based on data from Aerospace Industries Association of America.

[2] Section data not available.

[3] Recommended maximal number of passengers (Boeing).

[4] Includes treated air.

The levels of airflow to the passenger cabin provide an environment that meet or exceed requirements of FAR 25.831 and airline industry accepted criteria for safety. New requirements that may be established and imposed by the FAA involving health or improved comfort must be based on firm data.

Question 2. The NAS recommends extensive data collection to provide insight into the actual condition of cabin air quality. The NAS has developed a computer model to help with these investigations.

Have you seen the computer model and would it be useful to the aerospace industry in designing more efficient aircraft ventilation systems?

Answer. Our knowledge of the computer model is limited to the detailed discussion included as Appendix A of the NRC report. An evaluation based on a review of Appendix A is as follows:

The model would be of only limited usefulness due to its treatment of the passenger cabin and other areas as bulk homogeneous volumes. To properly assess the contaminant transport from volume to volume, the transport within each volume must be defined.

An example of this would be cigarette smoke concentration within an area of stagnating air. Since the ventilating air does not pass through this area the contamination levels could be many times higher than the levels predicted by the uniform mixing model. If this air in turn passes directly through to an adjacent volume, its contamination level would be similarly higher. This would cascade throughout the system.

Since the transport within the volume must be defined before this model can be used, the purpose of predicting the transport is defeated.

Other problems include:

Equation (1) (Page 226) does not appear correct, the more common expression is:

$$\frac{dc}{dt} = \frac{P}{V} - \frac{L}{V}$$

so

$$\frac{dc}{dt} = \frac{P}{V} - \frac{Qc}{V}$$

V = volume of box.
L = Qc.
L = rate of loss of pollutant.
Q = total flow out (pollutant and air).

This solution does not allow for boxes that exchange with more than two other boxes (Page 230).

The need for non-linear models may arise, i.e. airplanes flying short routes may not attain steady state conditions (Page 226).

The .5 L/Min CO_2 generation rate (Page 236) does not equal 760 mg/min (more like 980 mg/min).

Figure A-1 Page 227 should be labeled as Box 0 of Figure A-3.

Figure A-2 is A-3 and vice-versa.

We believe that computer models could be developed by the aircraft industry that would be more useful in evaluating airliner cabin air quality.

Question 3. The NAS found that increasing the ventilation rate of the airline cabin to adequately improve cabin air quality was not cost effective.

Are aircraft ventilation systems currently built to perform at maximum airflow, as recommended by the NAS?

How many cubic feet per minute per passenger would this provide with a full passenger load?

Could the ventilation system be built to provide greater amounts of cabin air in a more cost effective manner—for example by using a separate generator for the operation of the system rather than bleeding the engines?

What would it cost to provide the levels of fresh air found in the environments on the ground, such as trains or theaters?

Answer. Merely increasing the ventilation rate may not result in "improved" air quality. Factors to be considers are: (1) maintenance or increase in ventilation effectiveness, (2) provision of comfortable space air velocities, (3) provision of comfortable temperature gradients and (4) maintenance of acceptable sound levels.

Airliner environmental control systems presently provide ventilating air in a most cost-effective manner. Sources other than the engine have been considered; e.g., the auxiliary power unit (APU), but have been found to be less cost effective.

Air distribution techniques for trains, theaters, airplanes, etc. are different and the effect of fresh air on air quality cannot be equated easily. However, citing a McDonnell Douglas/NASA study, fuel costs would increase $1 million per airplane per year if design changes were made to provide air quality equal to a smoke-free cabin in today's airplanes.

Question 4. What warning systems are currently built into aircraft to alert the crew that pressurization limits are being exceeded?

Answer. Warning systems currently built into aircraft for pressurization system anomalies are required by FAR 25.841; i.e., instruments to show cabin-to-ambient pressure differential, cabin pressure altitude and cabin pressure rate of change and an aural or visual signal that warns the flight crew when the cabin pressure altitude exceeds 10,000 feet.

Question 5. NASA information cited by the Aviation Safety and Health Association in its testimony on September 19th speaks of cosmic radiation exposures of up to 8,000 millirems per hour on a 5- to 8-hour flight. Is this level safe and appropriate?

Does it exceed the maximum recommended level for crew and passengers?

Should there be a warning for air travellers relating to these high levels of radiation?

Is the public exposed to such radiation levels on the ground, and if so is the public informed or warned regarding the potential dangers thereof?

Answer. We are not familiar with the information cited by ASHA. An 8,000 millirem per hour exposure obviously exceeds the 500 millirem per year recommended maximum for any member of the general public. Examination of Figure 5-4 of the NRC report will show that the cited radiation exposure level may be in error. The National Commission on Radiological Protection could make a judgment on the ASHA quoted exposure rate.

Senator **KASSEBAUM**. Thank you, Mr. Hainline.

Mr. Phillips, I would like to ask you, has ATA done any data collection of its own?

Mr. **PHILLIPS**. On cabin air quality?

Senator **KASSEBAUM**. Yes.

Mr. **PHILLIPS**. Not on a systematic basis, no.

Senator **KASSEBAUM**. Do you see a need to establish some standards of evaluation and, if so, should the FAA or EPA be responsible?

Mr. **PHILLIPS**. Certainly to the extent that new requirements are established, they should be based on some sort of need and demonstrated actual requirement. I suppose we would support a data collection effort to demonstrate those things.

FAA is the agency primarily responsible for safety regulation, and since these activities seem to be so interrelated, it would seem appropriate to us that FAA also be given responsibility on general cabin air quality measurements.

Senator **KASSEBAUM**. Mr. Hainline, has AIA done any estimate of costs? Senator Inouye asked Mr. Halfpenny, I believe it was, about the cost of any effort to enhance air quality.

Have you any figures on what the costs might be?

Mr. **HAINLINE**. Not specifically because it is difficult to estimate the costs when you do not know what the standard will be.

Senator **KASSEBAUM**. We get back to the need, I guess, to somehow come up with something more concrete to work from as we try and assess the impact of the air quality.

Senator Exon.

Senator **EXON**. Madam Chairman, thank you very much.

Just let me ask the panel, any member of the panel that might respond so that I could understand a little bit better the situation; I do understand the present situation on commercial airlines is that only cigarette smoking is allowed, and most airlines have designated certain smoking sections and nonsmoking sections.

What about the crew? In some of the testimony, there was a statement made about the cabin crew and the crew in general. Are they allowed to smoke in the cabin while passengers, by and large, are relegated to two areas?

Mr. **PHILLIPS**. It is my understanding, Senator, that there is no restriction on smoking cigarettes on the flight deck.

Senator **EXON**. On the flight deck.

I am curious as to why that is. As a pipe smoker, I have learned to give up that business of smoking my pipe for 2 or 3 hours. It has not hurt me a bit, so I don't believe it has injured my health in any way, shape or form. I guess you are telling me, though, that crew members cannot smoke pipes and cigars in the forward cabin or on the flight deck, but they can smoke cigarettes?

Mr. **PHILLIPS**. I understand that is at the captain's discretion. Yes, sir.

Senator EXON. What is the rationale behind that? Can you explain to me what that is? If you can't smoke on an airplane, I would think that the crew itself would be the first under the rules and regulations to live up to what is supposed to be good for others.

Certainly there is a move afoot to discourage any kind of smoking, including cigarette smoking in society in general today, and I do not quarrel with that. I guess I do not quite understand why, if it is not good for air quality on airlines for people to smoke anything, then why is it that the rules do not apply to the crew.

Ms. DEEGAN. In the regional airline industry, our industry, many of them do ban as a company policy, cockpit smoking for maintenance reasons, as also for the health of the crew. And many of our companies have been adopting some no-smoking policies in general.

Again, our flights are only 45 minutes. I guess people can go without a cigarette for that long. The longer flights may have a different criteria.

Senator KASSEBAUM. Senator Inouye.

Senator INOUYE. Mr. Phillips, I gather from reading your testimony that you do not believe that banning of cigarette smoke is warranted. Is my conclusion correct?

Mr. PHILLIPS. As of now, Senator, we have not seen a definitive medical conclusion that requires banning of smoking. Right now we have a regime and regulatory environment that accommodates both smokers and nonsmokers in a rather satisfactory way, at least from our perspective. And we would like to maintain that arrangement.

Senator INOUYE. And you are also suggesting that it is not fair to single you out, and that your cabin environment is about the same as other transit modes; is that correct?

Mr. PHILLIPS. Yes, sir.

Senator INOUYE. Are you suggesting that a passenger on a bus and a passenger in a 747 on a cross-continent flight are in the same category? On a bus you can open the window, or you can get out at the next stop. And, most importantly, the air that is circulated within the confines of the bus comes from the outside, at least part of it.

Mr. PHILLIPS. What I have suggested, sir, is that sufficient study has not been made to distinguish air transportation separately from the world we live in.

Senator INOUYE. I am certain you have been on a bus. They do not permit smoking on buses.

Mr. PHILLIPS. Yes; I have been on buses where they do not permit smoking.

Senator INOUYE. And many restaurants and offices now prohibit smoking.

Mr. PHILLIPS. Yes, sir.

Senator INOUYE. Don't you think there must be some basis?

Mr. PHILLIPS. We have accommodated the desires of nonsmokers to have a nonsmoking environment on airplanes as well, sir.

Senator INOUYE. So I am on row 4, and rows 1, 2, and 3 permit smoking; row 4 is nonsmoking. I am in a safe environment.

Mr. PHILLIPS. I assume you are in a safe environment until I see a study that demonstrates you are not.

Senator **Inouye**. You mean to tell me that the smoke generated in rows 1, 2, and 3 is kept within that zone?

Mr. **Phillips**. Obviously, the closer you are in a smoke environment, the nearer you are to it, you have some relationship to the smoke.

You are addressing the question of whether there is adequate circulation and sufficient clean air. As far as I know, there is.

Senator **Inouye**. Do you consider the findings of the Surgeon General of the United States to be serious enough for the Air Transport Association to look at it seriously?

Mr. **Phillips**. I am not sure what specifically you are referring to, sir.

Senator **Inouye**. Well, if you smoke, on every pack there is a warning. The Surgeon General has issued a warning almost every 3 months or so. I am certain you have seen those.

Mr. **Phillips**. Yes, sir; and people smoke at their peril if they wish to do so.

Senator **Inouye**. Well, what about humidity? Should we be concerned about humidity? The witness in the last panel suggested that there is no humidity making device on these aircraft, but all of the humidity that I get on my flights to Hawaii and back comes from your perspiration and your breath. That should suffice, do you think?

Mr. **Phillips**. I understand that at high altitudes and long distances, the cabin can be dry and it is difficult to establish a safe and feasible humidification. Common advice for people in that situation is for them to consume a lot of liquids, not alcoholic liquids, but water and juices. And people who live in dry atmospheres, in desert environments in the Southwest, have learned to accommodate that very much the same way.

Senator **Inouye**. Let us not compare the dry air in Arizona with the air up in the cabin. You are not doing that, are you?

Mr. **Phillips**. No; I am addressing the question of humidification and its absence and its effect on people, and the way to accommodate that is to consume liquids.

Senator **Inouye**. Mr. Hainline, is there any way that we can provide better humidification on an aircraft?

Mr. **Hainline**. Yes; it can be provided. It will cost you economically. It will cost weight. It will cost additional equipment. It ultimately will raise the price of your ticket.

Senator **Inouye**. About how much?

Mr. **Hainline**. I do not know the answer to how much. It is according to how much humidity you provide. So far, if you look at the NRC report, there are not any real standards for humidity. There is not any evidence that humidity is a health problem, so there has been little effort in that line. A few airlines have provided some humidification equipment for their airplanes, especially in some of their flight decks for the flight crew, where they have extremely high ventilation rates which are put there to accommodate electronic equipment as opposed to comfort for the flight crew.

In fact, many of the flight crew complain about the amount of fresh air. Maybe I should not say fresh air. The amount of air that they have in the cockpit because it is more breezy than they would prefer to have it. So the more air you put in the cockpit, then the more requirement you have for humidity, because you do not have the benefit from the mutual effect of other people which does raise the humidity in the compartment.

The more you improve the air quality by adding extra fresh air, the more you will reduce the humidity.

Senator **Inouye**. Whenever I fly I receive instructions, either by film or in person. I think there are four parts to that: seat belts, escape routes, this thing that falls down, and how to prepare yourself for a crash.

Now, do you have any response to the suggestion of the last panel that the air or the oxygen, all it serves is to give false security?

Mr. **Hainline**. I would not say that oxygen gives you false security, but if you are addressing the problem of the oxygen capability for in-flight fire and smoke, yes, it is not useful for that purpose. And we do not in our instructions on our airplanes suggest that it be used.

We say in case of a fire, do not deploy the emergency oxygen equipment. The oxygen equipment can be deployed automatically or it can be deployed by the flight crew. It is not useful for smoke protection.

Senator **Inouye**. You are in the business of designing and manufacturing. Do you have any idea why none of the airlines, at least the ones I have been on, give any instructions relating to smoke or fire? And yet, a lot of the deaths and injuries are caused by smoke and fire, I think much more than result from the actual crash.

Mr. **Hainline**. Well, I can only conjecture why they do not do that, so take it for what it is worth. When you consider fire and smoke, there are a number of smoke incidents that happen in flight in airplanes. Usually they are minor things. Light ballast failures, smoke, some miscellaneous electronic equipment on the flight deck; sometimes smoke in the passenger compartment. They are minor incidents.

And if you put in a passenger's mind that this might be a crisis, you might create more chaos than you do good. Yes, there have been a few instances of in-flight fires that have been catastrophic—like four in the history of U.S. jet transport aviation. And when they happen, they can be catastrophic, as you well know.

So our approach has been if this happens and it happens on the ground, you should get the people out as fast as possible. And that is where there are some instructions on evacuating the airplane and we would put the emphasis on evacuating the airplane, getting the people out, rather than trying to tell them how to survive inside the airplane.

Senator **Inouye**. I haven't any other questions I would like to submit. Thank you very much.

Senator **Kassebaum**. All right. I would like just to ask Ms. Deegan one more. Is it correct that there are separate smoking sections on regional carriers seating between 30 and 60 passengers?

Ms. **Deegan**. That is correct.

Senator **Kassebaum**. Have passengers had any particular complaints about having smoking sections?

Ms. **Deegan**. One of our airlines attempted to ban smoking. They flew less than 30-seat aircraft, which by law they had to ban, and they went into some larger aircraft and they tried to ban on the larger aircraft and they had so much protest from passengers that they have reinstated the smoking section.

So we have not had any unusual complaints. I find it also interesting that there really has been very little comment or anything about having the ban on the less than 30-seat, very little information on it. It has been in effect now for 2 years.

Senator **Inouye**. Madam Chairman, I am pleased to advise the committee that in the State of Hawaii on all interisland flights, none of the certified airlines permits smoking.

Senator **Kassebaum**. And there have been no complaints?

Senator **Inouye**. No complaints.

Senator **Kassebaum**. Senator Exon.

Senator **Exon**. One question I would like to ask Mr. Hainline. In this era of deregulation, have there been any studies done in the airline industry with respect to the construction of a section in an aircraft that would separate the main passenger seating section from a smoking section, somewhat like what we used to have on trains, where there would be one car that was a smoking car.

I remember one time when I traveled on a Boeing 747 overseas—and I think overseas flights are the ones we are probably most concerned about. You made, Ms. Deegan, a point that most of your carriers are 45-minute flights. I would suggest that probably most domestic flights today are no longer than an hour and a half.

I do not believe that our domestic flights are of critical concern. It does not affect me one way or the other because, as I said, I have learned not to smoke my pipe—which is a clean smoke, I would suggest to you.

But it seemed to me that on one of my flights overseas, they had that upper compartment in the 747. I believe they had that designated as a smoking section. And at least when I was up there puffing away, even on my pipe, I felt that I probably was not doing any injury to any other passengers, whom I do have a feeling of concern for.

It seems to me that in this time of trying to attract passengers to not only the best service but the most comfort, it might not be a bad idea for the airline industry to at least have sketches and drawings available, especially for overseas travel aircraft primarily, for a separate section that could possibly be designated as a smoking section.

Is it not possible, under the scenario that I am outlining to have a totally safe environment for smoking for those who have to smoke or feel they need to smoke, and yet provide full protection for those that have serious objection to it for health reasons and others?

Mr. **Hainline**. I think you had a couple questions, sir. I think the first one you asked—have we looked at special compartments for smoking? I think the answer is no, we have not done that, but we have done other things. In the first place, the airlines like a lot of flexibility in what they can do with airplane interiors. One airline wants to do one thing with their airplane; another airline wants to do another thing. So they like to have flexibility in where the first class stops and starts and where the economy and business classes go and so forth, and seat pitch and that sort of thing. So they do have different passenger densities in different parts of the airplane.

The air-conditioning systems and the ventilation systems on commercial airlines are designed primarily to take the air, bring the air in and run it laterally across the airplane in a circulatory motion, such that it tends to stay within a row, trying to keep it from moving longitudinally in the airplane. So that helps isolate the smokers from the nonsmokers. And you will find that if you measure smoke in a smoking area and smoke a couple of rows away, there is a significant difference in what the environment is.

We also try to provide enough air velocity locally over the people so that the air does not feel stagnant, and yet velocity not so high that you feel like you are in a draft. So there is a fine balance between the velocities of ventilation that go across people. We do try to keep the air going laterally across the airplane.

Senator **Exon**. Well, when I was puffing away up there in that upstairs room on the 747, I was convinced that I was causing no harm or irritation to other passengers.

Was I justified in that, or was that a figment of my imagination?

Mr. **Hainline**. No; I think you were justified. On the 747 there are five zones of air-conditioning on the airplane. There is one for the flight deck, there is one for the upper level, and there are three in the lower level portions.

Senator **Exon**. So my smoke was separated from the general passenger cabin?

Mr. **Hainline**. Yes; it went down into the cargo hold and down around the cargo hold and out through the outflow valves in the back of the airplane.

Senator **Exon**. Thank you.

Senator **Kassebaum**. If there are no other questions, I think that completes this panel. Thank you very much.

The next panel is Mr. Finucane and Mr. Trask.

It is a pleasure to welcome the next panel: Mr. Peter Trask, president, Aviation Safety and Health Association; Ms. Achenbaugh, Flight Attendants Association; and Mr. Matthew Finucane, director of air safety and health. It is a pleasure to have you here.

STATEMENTS OF MATTHEW H. FINUCANE, DIRECTOR, AIR SAFETY AND HEALTH, ASSOCIATION OF FLIGHT ATTENDANTS, ACCOMPANIED BY NORVA ACHENBAUGH, CHAIRPERSON, HEALTH COMMITTEE; AND PETER L. TRASK, PRESIDENT, AVIATION SAFETY & HEALTH ASSOCIATION

Mr. **Finucane**. Thank you, Madam Chairman. Delivering our testimony will be Norva Achenbaugh, a flight attendant with over 10 years of experience and also chairperson of our health committee.

Ms. **Achenbaugh**. Good morning. I would like to thank you for this opportunity to testify on behalf of the Association of Flight Attendants. We represent approximately 25,000 flight attendants at, hopefully as of this morning—if there have been no mergers overnight—16 U.S. carriers.

The flight attendants can have only one reaction to the National Academy of Sciences report and that is fear—legitimate fear for our health. Even couched in its conservative, scientific tone, the

NAS study suggests that there are several disturbing possibilities. The study suggests that pregnant flight attendants may be exposed to radiation levels high enough to double the likelihood of childhood leukemia and cancer in their offspring.

It suggests that passenger smoking could markedly increase our risk of developing lung cancer. It suggests that we may be exposed to a large number of recirculated viruses. And it suggests that inadequate, nonexistent monitoring of ozone, carbon monoxide, carbon dioxide, and other pollutants allow an unhealthy environment that would lead to a wide variety of acute and long-term respiratory diseases or illnesses.

Like all American workers, flight attendants are willing to give their sweat and tears for their job, but we really do not think it is necessary that we give our lives for our jobs as well.

Actually, we are ready to make enormous sacrifices to get passengers out of post-crash fires and to deal with other emergency situations, but we are not willing to make those sacrifices so that the airlines can skimp on ventilation rates or continue to take a cavalier attitude toward measuring cabin pollutants.

We have another cause for fear. Our fear is that the Federal Aviation Administration will say a few nice words about the National Academy of Sciences study, make a few promises, and then go back to ignoring the issues as usual. The FAA is an agency with a handful of front burners and a thousand back burners.

It is an agency extraordinarily influenced by the wishes of the airlines who will not want to spend a penny to solve the problems raised in the Academy study. And it is an agency with no internal structure—no office, no person, no program—that is responsible for the flight attendant and passenger health.

As a result, we fear that without the intervention of Congress, the National Academy of Sciences study will end up on one of those burners so far back that we will not even know if it is on.

In 1970, the Congress of the United States made a bold promise to American workers in the Occupational Safety and Health Act. They promised a healthy and safe workplace and created a system of agency regulations, inspections, and fines to make the promise a reality. That promise has not benefited flight attendants. In 1974, the FAA issued a policy statement claiming authority over flight attendants' health issues in order to keep OSHA off aircraft. While the FAA has succeeded in keeping OSHA out,[1] the agency has treated its claim over crewmember health with the same attention as if it had staked out a land claim on Mars. At least for this century, the agency shows no sign of activity.

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[1] Although the Federal courts have found that an actual exercise of another agency's jurisdiction is needed to preempt OSHA jurisdiction, the FAA's opposition to OSHA's efforts in aviation areas has led to de facto FAA control over almost all aviation-related issues. Thus, in 1979, OSHA wrote AFA that "OSHA's jurisdiction would have little or no application in the case of exposure of flight attendants to in-flight hazards." Flight attendants, for all practical purposes, must rely upon the FAA to monitor and regulate flight attendant health issues. In order to clarify conflicting responsibilities, OSHA has entered into formal agreements with other agencies, e.g., the Coast Guard and the Mine Safety Administration. OSHA and the FAA have not entered into such an agreement, although they were close to one in 1980, and were encouraged to do so by the House Committee on Government Operations. H.Rept. 97-393, 97th Cong., 1st sess. (1981). However, an interagency agreement would not be a panacea for crewmember health problems, since it merely shows the intent of the parties to the agreement, and does not *per se* lead to any organized health activity by the parties.

In the area of cabin air quality, the result has been, for example, that the vague FAA standard for ventilation in the passenger compartment is the same as the USDA standard for transportation of hamsters and guinea pigs in a cargo compartment.

We therefore urge Congress to urge the FAA to live up to the responsibilities that it has claimed in the health area. The agency should set up an office devoted to crewmember and passenger health. It should staff the office with qualified health inspectors. The agency should perform the studies suggested by the National Academy of Sciences. It should write rules protecting crewmember and passenger health, beginning with the ones recommended by the NAS.

Although we understand the difficulties Congress faces in balancing the Federal budget, we would urge that funds be made available for such an office within the FAA. In our view, it could operate with less than 10 persons, a modest number to address the health concerns of over 100,000 crewmembers and tens of millions of passengers. Such an office would more than fulfill the recommendations of the Academy that a Federal agency take jurisdiction over health issues and that the FAA establish a program to monitor health effects on crewmembers.

We would like now to address four specific recommendations from the study. First, with regard to smoking, the Academy estimates that flight attendants are being exposed to sidestream smoke equivalent to living with a pack-a-day smoker. This amount of passive smoking, the Academy suggests, is associated with an increased risk of lung cancer.

Since lung cancer may soon be the leading type of cancer among women, the Academy's recommendation is of extreme importance to us and we hope that Congress, the Department of Transportation, and the FAA will give the recommendation thorough consideration in spite of the controversy surrounding this issue. We know that the Department of Transportation has said this problem can be solved through the marketplace, but flight attendants, who are at the greatest risk, cannot switch carriers from month to month depending on which airline will be experimenting with nonsmoking flights.

The marketplace cannot protect flight attendants from lung cancer. The Government must do that through a carefully crafted rule that will maximize health and safety.[2]

The second NAS recommendation which we believe deserves urgent attention concerns radiation. The Academy urges better monitoring of radiation levels in order to protect pregnant flight attendants. We believe that pregnant passengers may also have reason to be concerned. According to the Academy, solar flare activity occurs on an average of seven times per year, delivering hundreds of millirems per hour to those at that altitude. If this is the case, a pregnant passenger flying during solar activity might receive excessive radiation. It seems to us that a system of warning passengers and flight attendants needs to be developed.

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[2] Safety is a consideration since a ban on smoking might affect lavatory smoking, depending on the effectiveness of the smoke detectors. On the one hand, a ban on smoking has the potential for lessening smoking in lavatories, since passengers currently consider the aft section of the aircraft as a kind of smoking salon, an impression that carries over to the lavatories. If passengers did not have any expectation of smoking aboard aircraft, smoking in lavatories should decrease. On the other hand, some passengers might surreptitiously smoke in the lavatory if forced to go without cigarettes for several hours. At this point in time, our balancing of these issues leads us to support a ban on flights of 2 hours or less, although our minds are open on this point.

A third area addressed by the Academy which should be pursued is passenger protective breathing devices. There is no reason the passenger should not be supplied with a clean air source during an inflight fire, yet the current oxygen mask that pops down supplies a mix of both oxygen and what would be smoke-filled ambient cabin air.

The state of the art has progressed to the point where the agency should consider requiring modifications of oxygen systems on new aircraft or the use of other technologies such as smoke hoods with an internal air or oxygen supply. Although the airlines would find such hoods quite expensive, there is nothing like a notice of proposed rulemaking to hasten research into low-cost technology.

Finally, we would urge that Congress take steps to ensure that all of the studies recommended by the Academy are performed. In addition to radiation, the Academy recommends systematic measurement of "carbon monoxide, respirable suspended particles, microbial aerosols, and ozone and the measurement of actual ventilation rates, and cabin pressures."

Although other agencies and groups might have more expertise in these areas, the FAA should be required to perform these studies so that it can simultaneously develop the expertise to regulate if necessary. Moreover, many carriers refused to allow the National Academy of Sciences on board their aircraft to take measurements, so it is important that those charged with doing further studies have the statutory authority to perform them. In our view, the FAA has such authority, although any additional legislation should reemphasize this.

In closing, we would like to thank the Academy and this subcommittee for its attention to crewmember and passenger health issues and we would like to particularly thank Senator Inouye for his tireless efforts on behalf of cabin air quality.

Thank you.

[The questions and answers follow:]

Association of Flight Attendants AFL-CIO,
Washington, DC, November 10, 1986.

Senator Ernest F. Hollings,
Ranking Democrat, Senate Committee on Commerce, Science and Transportation, Washington, DC.

Dear Senator Hollings: In response to the follow-up questions which you submitted on behalf of Senator Inouye concerning the Aviation Subcommittee's September 19th hearing on the National Academy of Sciences report on airline cabin air quality, we are pleased to provide the following responses:

1(a). Under current conditions, do flight attendants feel the ventilation of the cabin is sometimes inadequate?

We have received hundreds of complaints from flight attendants about the quality of ventilation aboard aircraft. Indeed, we consider it a daily problem. To some extent, a few airlines recognize this problem and discourage operation of the aircraft with less than full ventilation. This should be required on an industry-wide basis, either by regulation or by law.

The FAA could currently require full ventilation by strictly interpreting its regulation requiring adequate ventilation. As the NAS points out, the ventilation rates are inadequate compared to what is provided in buildings.

1(b). What means are available to flight attendants to get the airflow rate to be increased?

At airlines that discourage use of full ventilation, there is little the flight attendants can do when passengers begin to suffer from lack of ventilation. They can report the problem to the pilot, who in his discretion, can increase ventilation. However, pilots are monitored at some carriers for fuel consumption and this is a disincentive to increasing ventilation. In addition, at at least one carrier, the pilots confronted with complaints were instructed to increase ventilation in the smallest increments possible, e.g., from two airpacks on low to one on low and one on high; then to two on high; then to three on low; etc. (This carrier moved to operating all three packs about the time the NAS study was released.) Some European carriers currently have the cabin recirculation systems under the control of the flight attendants who can assess cabin conditions or respond to passenger requests or complaints.

1(c). Do you think that increasing the infusion of fresh air would have a significant effect on cabin air quality?

Increasing fresh air would eliminate many hazardous gases, particles, and bacterial contaminants from the air and would also increase the proportion of oxygen in the cabin. Given the vast number of passengers who are disturbed by poor cabin air quality, increasing the infusion of fresh air is both logical and necessary.

2(a). Regarding radiation, does AFA feel that flight attendants are currently given adequate warning as to the dangers associated with cosmic radiation?

Flight attendants are currently, in our experience, given no warning about radiation even though the amounts of radiation some are receiving, according to the Academy, could increase the likelihood of their offspring having childhood leukemia or cancer. Pregnant passengers who travel a great deal, or who have the misfortune of traveling during a solar proton event, might also be exposed to excess radiation without warning. The FAA has stated that it will be providing advisory material to the industry on radiation exposure, but we believe that this advice may not be based on scientifically valid estimates of current exposure at altitude.

2(b). What do you suggest as a way to address this problem in order to provide the maximum protection for cabin crew?

Further research needs to be done into whether satellite information can be used to warn flight attendants and passengers of solar events. In addition, as suggested by Mr. Edward Bramlitt in his petition for rulemaking, the FAA should move toward monitoring actual crew exposure to radiation. With actual monitoring, crewmembers and passengers would be able to self-limit exposure. The Air Force currently has a test program in place for monitoring flight crew exposure to cosmic radiation, and has suggested a willingness to work with the FAA in this area.

3(a). What are AFA's views on the current equipment and procedures available in the case of an in-flight fire?

Training of flight attendants for dealing with in-flight fires is inadequate and varies widely from carrier to carrier. Many flight attendants do not deploy extinguishers in training, for example, even though this is required by regulations. Drills involving "fire" are extremely rare. The equipment for dealing with in-flight fires is also inadequate. For example, there is no protective breathing equipment for flight attendants on most aircraft. Although the FAA has issued an NPRM in this area, a final rule could be delayed by the Secretary of Transportation or OMB.

Passenger protective breathing equipment is an area that desperately needs to be examined. As a result of the Manchester fire, the European community is looking carefully at passenger smoke hoods, with an internal air or oxygen supply to handle an in-flight fire and a post-crash evacuation. The current face mask that provides oxygen to passengers in a decompression is useless in an in-flight fire, since a valve in the mask allows in smoky, poisonous cabin air. The FAA should push the industry in this area by issuing a proposed rule.

3(b). Should these procedures be included in the pre-flight passenger safety briefing?

To the extent that there is anything passengers can do to increase survivability in an in-flight fire, this should be in the briefing. The key would seem to be to provide them with protective breathing devices so that they will not die before landing, and to improve their knowledge of exit location in case vision is obscured.

Respectfully submitted,

MATTHEW H. FINUCANE,
Director of Air Safety and Health.

Senator KASSEBAUM. Mr. Trask.

Mr. **Trask**. Good morning, Madam Chairman and members of the subcommittee. My name is Peter L. Trask, and I am president of the recently formed nonprofit Aviation Safety & Health Association. We appreciate this opportunity to present our views on the National Academy of Sciences report concerning airline cabin environment under Public Law 98-466.

I am an attorney and have been in private practice since 1977 and have been personally involved with Public Law 98-466 since its inception in 1980. ASHA was incorporated exclusively for educational purposes relating to the recognition, substantiation, verification, and promotion of an advancement in the public interest of policies, procedures, and remedies of aviation and safety health issues confronting aviation employees and passengers.

ASHA's board of advisers consists of a variety of professional individuals, several of whom have appeared before this subcommittee and participated in some manner with the NAS study under Public Law 98-466. Others have been well known in the field of aviation for some time.

ASHA was formed out of an apparent lack of medical and scientific information available to the flying public concerning possible health and safety hazards associated with high-altitude jet travel. We are not a labor organization, even though our members include flight attendants, pilots, and ground crew personnel in the airline industry.

Our membership is open to the flying public. From that point of view, ASHA represents the interests of the approximate 800,000 daily flying individuals who should not feel fatigued or debilitated upon reaching their destination.

I am going to attempt to summarize our lengthy testimony and I would like to request that the full extent of our written text and the text by Mr. Bertil Werjefelt, who is a member of the board of directors, also be included in the record today if I may.

Senator **Kassebaum**. Without objection.

Mr. **Trask**. Thank you.

We want to commend the National Academy of Sciences for the effort and hard work necessary in complying with Public Law 98-466. The study and the report is a giant step toward recognition and resolution of the many issues raised by the act. However, we have several concerns which we feel compelled to raise at this time. These concerns are not to be interpreted as a reflection of NAS capability, but a reflection of the lack of cooperation of the airline industry and the Federal Aviation Administration as given to the NAS effort.

Of importance, which I would like to start off first, is that we believe that the primary concern under the act was misdirected. For example, section 1(a) of the law—and I will quote directly from the act—states that "The study shall determine whether civil commercial aviation industry practices"—and I emphasize the word practices—"and standards and Federal aviation rules and regulations and minimum standards are nondiscriminatory"—and I emphasize the word nondiscriminatory—"and at least in conformance and parity with non-aviation standards, practices, and regulations for the appropriate maintenance of public and occupational health and safety in relation to airline cabin air quality for all passengers and crew aboard civil commercial aircraft."

Public Law 98-466, Section 1(a) states in pertinent part that:

> The Secretary of Transportation shall, in the interest of health and safety, and in the interest of promoting and maintaining a superior United States aviation industry, commission an independent study by the National Academy of sciences. The *practices and standards* and Federal Aviation Administration rules, regulations, and minimum standards are *nondiscriminatory, and at least in conformance and parity with nonaviation standards*, practices, and regulations for the appropriate maintenance of public and occupational health and safety (including *de facto* circumstances) in relation to airline *cabin air quality* for all passengers and crew aboard civil commercial aircraft. (Emphasis added.)

Accordingly, the study shall determine whether civil commercial aviation industry practices and standards and FAA rules, regulations, and minimum standards are nondiscriminatory as defined in Commerce Committee Report 98-468 accompanying S. 197.

From information we have been able to obtain, the FAA Statement of Task to the NAS made no mention of section 1(a) of Public Law 98-466 (A copy of what we believe is the FAA Statement of Task is attached hereto as Exhibit "A"[1] and incorporated herein by reference). We believe NAS could have misinterpreted its charge after reviewing the FAA Statement of Task.

As a result, we note that the NAS report is devoid of any references to current industry practices with respect to any of the 10 items NAS was to address under Public Law 98-466. However, the NAS report does identify what current regulations exist with respect to manufacturing standards. A critical example of this problem is in the airpack operation.

We have been able to document current airline policy to operate with less than all airpacks during inflight procedures—a copy of such an airline policy is attached as exhibit B7. Since airpack operation is a likely culprit in cabin air quality, why wasn't current industry practices confirmed so that resolution could be recommended? Confirmation of such practices is necessary because industry and FAA reaction to the first legislation proposed by Senator Inouye in 1981 and a petition for rulemaking filed in 1980 on similar safety and health concerns by Xenere Corp., denied the existence of any problems at all.

Since the NAS has confirmed a lack of existing public information on the cabin environment, it was unable to consult previous studies on the environment. In the absence of such information, a determination of what precisely is going on in the cabin environment becomes the only way NAS could begin to address the parameters of the issues presented in Public Law 98-466.

Without a determination of industry practices and its effect on the people within the cabin environment, NAS is unable to recommend resolutions to most of the items required to be addressed in Public Law 98-466.

The next issue we want to raise—there is going to be a lot and I apologize, but we were asked to testify last week Friday, and it was rather hectic trying to put this together—another matter not considered or at least reported by the NAS study is the question of whether current industry practices and FAA regulations are nondiscriminatory. Committee report 98-466 defines nondiscriminatory as referring to the difference in standards in health and safety as applied to passengers and crew. The example cited by the committee is the difference between the quality of air in the cabin and the cockpit.

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[1] The exhibits A-D were not reproducible.

Abundant information has been available justifying the cockpit receiving 100 percent fresh air through an independent temperature control system. The NAS report confirms cockpit ventilation rates as high as 150 cubic feet per minute per crewmember in order to meet avionic and electronic equipment cooling loads, rather than for reduction of contaminant concentrations.

However, this NAS statement is inconsistent with the statement made by the vice chairman of the NAS committee who stated in a previous article—and I quote: "In a 1952 survey conducted by the A9 committee of the SAE, flight crews complained about the discomfort of the dry cabin air, the increased incidence of colds and debilitating effects of smoke and odors resulting from recirculation of the cabin air into the flight station. As a result of these objections and other developments, regulations have been established that require that the flight stations be supplied with 100 percent fresh air through an independent temperature control system."

We have attached a copy of this article to our written statement as exhibit C.

ASHA requests review of this inconsistency and confirmation of the need to provide 100 percent fresh air ventilation to the cockpit when recirculated air could also be used to cool the equipment.

In view of the historical note many questions beg response. If the aircraft environment had debilitating effects on pilots in 1952, then why did the industry deny such effects exist to the cabin crew and passengers in 1982?

If the answer is increased fresh air for the pilots, then why isn't the answer increased fresh air for flight attendants and passengers?

Is the policy and practice allowing and mandating 100 percent fresh air to the cockpit discriminatory under Public Law 98-466?

Other ASHA concerns include, but are not limited to:

QUANTITY AND QUALITY OF FRESH AIR

What is the NAS recommended minimum fresh air ventilation standard?

What is the NAS recommended standard for pack operation with full load and smoking?

HUMIDIFICATION

There currently is no standard for humidity regulation. There is also confusion as to current practices. In 1980, the ATA in response to a petition for rulemaking stated that humidification ranged for its members anywhere from 5 percent to 59 percent during flight.

What is the actual range? What is the NAS recommended amount of humidity? Is 5 percent too low? Is 59 percent too high? What is the corresponding fresh air ventilation rate in order to establish 59 percent humidity at cruising altitude? ASHA is advised that the fresh air ventilation is approximately 2.5 cfmp. This low fresh air ventilation rate indicates that recirculated air is exceedingly high in order to produce a humidity level of 59 percent.

RADIATION

The NAS study states: "Cosmic radiation dose rates, in rare events, can increase up to 2,000 rems per hour." However, ASHA is aware that radiation levels from sporadic solar cosmic rays can increase to exceedingly high exposure rates of the order of 8,000 millirems per hour and persist for periods of a few hours.

We cite the solar radiation monitoring for high altitude aircraft by J. W. Wilson, NASA, Langley Research Center, 1981.

ASHA is also informed that a large part of this solar radiation is neutron radiation which is more dangerous than ordinary x-rays. Is NAS aware of the NASA paper and does it recommend limited duty for pilots and flight attendants similar to that currently in existence with respect to current operation of the SST? Does NAS recommend radiation monitoring of the environment to provide radiation protection?

EMERGENCY BREATHING EQUIPMENT

The NAS asks the FAA to reinvestigate life-sustaining protective equipment. ASHA is aware of the dismal investigation record of the FAA. It has studied toxic fume protection for more than 25 years and has only concluded that it wants to direct its attention to getting the passengers out of the plane.

This philosophy is seriously flawed since it assumes the plane is on the ground for evacuation. What happens while the plane is airborne?

ASHA notes that pilots have had smoke protection equipment for almost 40 years; that passengers and flight attendants are confronted with identical life-threatening situations but have no protection equipment. Why? Is this policy discriminatory under Public Law 98-466?

ASHA questions the absence of an open discussion concerning emergency passenger toxic fume breathing equipment. This inquiry is based in part on the failure of the NAS to discuss an FAA October 1983 report entitled "Fire Management/Suppression Systems/Concepts Relating to Aircraft Cabin Fire Safety." In this 1968 report the FAA's own developed self-contained smoke protection hood was characterized in 1968 as "highly cost-effective, and suggested that a small compressed air source be added to extend its useful life." Yet, no smoke protection hoods have been implemented. We find references to FAA arguments against smoke hood protection for passengers incredulous.

We understand that the British are considering installation of smoke hoods. ASHA questions the absence of the above cited FAA report and ponders what, if anything, NAS would recommend with respect to smoke hoods had it known the entire history of smoke protection equipment consideration by the FAA.

PRESSURIZATION

The NAS study reports that it was unable to confirm reports of cabin pressure in excess of 8,000 feet, yet ASHA is aware that an investigative news team from KTSP-TV in Phoenix, AZ, performed its own pressurization check onboard the aircraft and found cabin pressure to be in excess of 8,600 feet.

The NAS report states that the likelihood of excursions above 8,000 feet is small, yet we can document one incident without difficulty.

The report goes on to state that regulations require inaudible or visible warning to be given to the crew if the cabin altitude exceeds 10,000 feet. ASHA inquires: Where are these alarms? Who sees them? Who hears them? And what is done about it?

Additionally, if the cabin pressure rarely exceeds 8,000 feet it seems inconsistent to require a warning system to be triggered at 10,000 feet. Why isn't the warning at 8,000 feet?

Finally, ASHA requests verification and confirmation of the cabin altitude necessary to trigger the oxygen masks to drop automatically. Our information leads us to believe that the oxygen masks will not drop until 11,000 or 12,000 feet.

The NAS study reports that because of pressurization changes, passengers with specific health problems might be at increased risk while flying. Leading the list of higher risk passengers are cardiovascular patients.

ASHA confirms and agrees with the American Medical Association paper on the medical aspects of transportation aboard commercial aircraft. In view of this requirement of public law, we find it almost appalling that the NAS report does not discuss nor refer to the only study of cardiovascular patients and jet travel by Dr. Danelo Canete, one of ASHA's board members.

COLLECTING AND DISSEMINATING INFORMATION

ASHA agrees with the NAS recommendation concerning the collection of data relating to the many elements of the cabin environment that affect the health and safety of the passenger and flight crew.

At this time, there is no entity charged with the obligation to collect and retain flight attendant reports.

ASHA would make the results of such program accessible to the general public.

COMPARISON OF FOREIGN PRACTICES, REGULATIONS, AND STANDARDS

While NAS did not perform an in-depth comparison of the differences between United States and foreign practices, regulations, and standards, ASHA directs the committee's attention to practices by Scandinavian Airline System [SAS] and British Airways concerning air pack operation.

ASHA is advised that SAS maintains air pack operation at all times, during taxi, takeoff, and landings. British Airways, we are told, instructs their crew not to leave air pack operation off for more than 5 minutes.

The NAS report recommends that because of the heavy potential risk of spread of infectious disease in an aircraft on the ground with no outside ventilation, no aircraft with passengers onboard remain on the ground without operational forced ventilation for longer than 30 minutes. In fact, according to NAS, microbial concentrations will begin to increase as soon as ventilation fails, and risks related to these exposures are unknown.

ASHA believes that in view of the NAS recommendation we believe SAS or British Airways has the more prudent approach that exemplifies a concern for their passengers.

THE BAN ON SMOKING

NAS recommends a ban on smoking on all domestic commercial flights. As a nonsmoker I personally sympathize with the situation. However, the smoking problem can be resolved by compelling the airlines to operate all airpacks during flight on full in order to accommodate smokers. The equipment is onboard. All ASHA suggests is that it be utilized.

ASHA bases its accommodation for smokers on our philosophy that we would prefer smokers to smoke in the cabin rather than in the lavatories where a smoldering cigarette could create a larger and potentially more dangerous situation. By banning smoking, the environment will only be removed of one contaminant that can be seen with the naked eye, whereas by increasing fresh air ventilation ASHA believes many other health concerns could be arrested by a higher flushing action.

With respect to those opponents of increased fresh air ventilation who believe it would be too expensive to carry extra fuel on board aircraft, we submit by way of the following example that it is not expensive at all.

In 1984, United Airlines inflight product representative circulated a memorandum concerning the operation of the third airpack on a DC-10-30 on trips to Hong Kong from Seattle. A copy of this memorandum is attached to our statement. In this memorandum it states that "operation of the third pack to Hong Kong will consume 1,700 pounds of fuel which costs about $260." If we assume that the airlines are flying with a full load, as is the practice under deregulation, the cost of $260 will amount to approximately an addition $1 per ticketed passenger, if that much.

I believe the passenger would be willing to pay that extra $1 if he knew that it would give him the comfort and protection from the health hazards confronting him in the cabin environment. ASHA believes the flying public already assumes the price of their ticket offers them this basic protection.

ASHA RECOMMENDATIONS

Our initial recommendation is to allow NAS to complete its review of the industry and FAA rules, regulations, and standards and practices consistent with Public Law 98-466. We suggest that NAS be required to work with and seek assistance with NIOSH and the Center for Disease Control and OSHA in order to perform random aircraft cabin testing. We believe Dr. Elliott Dick of the University of Wisconsin should also be involved. And by way of a note, Dr. Elliott Dick is also a member of our board of advisors.

We also suggest that the airlines be ordered to comply with inflight testing in order to confirm current practices.

Finally, we believe the Federal Aviation Act should be amended to repeal that portion of the act directing the FAA to promote aviation commerce. The act should then be further amended to focus on aviation safety only.

Again, I want to thank the committee and NAS for its efforts. We do not believe it is at fault for the statements made in its report, many of which have been previously made to this subcommittee in previous hearings on S. 1770 and S. 197.

We know how difficult the NAS task was. The information is sparse. The issues being interrelated have been difficult to define. In addition, NAS has relied on previously known opponents of Public Law 98-466 for information and cooperation. We note that no in-cabin environment studies have been allowed by the airlines which inhibited NAS factfinding. We support the purpose of Public Law 98-466 and stand ready to assist and provide to NAS whatever information we have at our disposal. Thank you very much.

[The statement and questions and answers follow:]

STATEMENT OF BERTIL WERJEFELT, DIRECTOR, AVIATION SAFETY AND HEALTH ASSOCIATION

Mdm. Chairman, Members of the Committee, Ladies and Gentlemen: I am Bertil Werjefelt, a director of the recently formed non-profit organization Aviation Safety and Health Association (ASHA). I am also the president of Xenex Corporation, an organization involved in basic proprietary research and development work in energy conversion systems. Our research ranges from the esoteric areas of nuclear, electromagnetic and photocatalytic systems, to the more ordinary energy conversion systems as can be found on aircraft for pressurization, ventilation and controlling contaminants such as ozone. We are also involved in research and development work on advanced closed-circuit breathing systems.

In my capacity with Xenex Corporation, I have previously testified before this Committee and committees on the House side, concerning aviation health and safety. Like Mr. Peter Trask, President of ASHA, I have been involved in these issues for a number of years, going back as far as 1980, when Xenex Corporation first filed a petition for rule-making with the Federal Aviation Administration (FAA) concerning cabin air quality issues. The cavalier treatment of that petition by the FAA led to the subsequent involvement of Senator Daniel Inouye, this and other committees, and finally, Public Law 98-466, and the National Academy of Sciences' report, which we are now discussing.

I wish to expand on Mr. Trask's statement regarding the 800,000 air travelers who daily use the air transport system in this country. Who are they? What is ASHA's role vis a vis these people?

First of all, many of these passengers travel by air because it has become the accepted and required mode of transportation for them to conduct their business. They are business managers, executives, engineers, doctors, dentists, lawyers, chemists, etc. Many of these people are the managerial and professional talents of this country, in other words, the management and staff of the Fortune 1,000 companies, as well as, of course, the same group of people for small businesses. There are legislators, scientists, and retired people. There are pregnant women, persons in excellent health, and those of marginal health. And obviously there are the pilots, flight attendants as well as ground personnel who fly for business and pleasure.

ASHA was formed to address health and safety issues confronting these air travelers.

The report recently released by the National Academy of Sciences in response to Public Law 98-466 is the first step in coming to grips with the health and safety problems in aviation. Unfortunately and disappointing to us is that this report does not fulfill the requirements of the law. We wish to stress, however, that we believe the NAS has performed its tasks in accordance with the instructions given to the Academy by the FAA. We do commend the committee members and all those who contributed to the completion of what we see as the first of several reports on aviation health and safety.

So why is it that this report does not fulfill the requirements of the law? Why does this report not answer the questions which this Committee, in prior investigations, have posed? Why does the report not even answer many of the questions posed in the law? We would like to know the answers, and I am sure this Committee would like to know as well.

To the best of our determination, as pointed out by Mr. Trask and as he and I discussed before this hearing, it seems in its instructions to the NAS, the FAA cited all other portions of the law, but omitted the basic section (1a), which prescribes how questions are to be answered by the NAS. In other words—what are the aviation industry practices? Are the industry practices discriminatory? Are the regulations discriminatory? Are they "in conformance and parity with non-aviation standards"? I. e., are there different health and safety considerations for pilots than for passengers? Are there different health and safety considerations or de facto circumstances for passengers versus occupants of an office building or a hotel or an apartment house? The fundamental objectives were to determine what needs to be done to create standards and practices that are non-discriminatory and, at least, in conformance and parity with non-aviation standards. There are very few of these questions that are answered by this document produced by the NAS.

The FAA cannot or is unwilling to recite the law correctly. This is not the first time we have run into this type of problem. We had hoped that the FAA, in spite of its poor past record in this regard (which is amply documented in the Senate hearing records on S. 1770 and S. 197), would have mended its ways. However, this does not appear to be the case.

In the FAA Statement of Task to the NAS we do not even see any mention of discriminatory or non-discriminatory. Moreover, the only mention the FAA made, relevant to "conformance and parity with non-aviation standards," were to transport standards.

The bottom line is that FAA instructions to the NAS were incomplete. How long is this Committee and those in the House and we, the public at-large, supposed to contend with this treatment from the FAA? At this point I believe it is appropriate to find out who is responsible? Why was this vital information withheld from the National Academy of Sciences? Withholding this information left the NAS to provide us with information about design of aircraft, rather than answering the question: what is actually going on? It is the same problem over and over again. In past hearings the FAA has been asked what the operational standards, rules, or practices are—they respond with design criteria. Now, it seems the FAA takes the law in their own hands to continue avoiding public disclosure of this information. The Senate, House of Representatives, and President Reagan have ordered the studies by law. The FAA has so far been able to block effective implementation of the law. In simple language: "Who runs the show?"

Mr. Trask has covered most of the ASHA concerns in his prepared statement. I would like to bring to your attention a few additional questions. For instance, the purpose of the law was to answer the question of whether or not the emergency smoke evacuation capabilities, by design and by practice, in the event of an in-flight smoke or fire emergency, are equal for the occupants of the passenger cabin to that of the cockpit. In other words, are the designs and practices non-discriminatory as it concerns the protection of the pilots and passengers against lethal fumes? And, if there are such capabilities in both cases, are they equally good or is one merely window-dressing, as compared to the other? Likewise with toxic fume protective breathing equipment: are the provisions of such equipment non-discriminatory? In other words, are both pilots and passengers provided with such protection or is it only available to pilots? We realize that the statement in the NAS report says that the FAA should reconsider or reinvestigate this matter.

The law inquired from the NAS whether or not there was equal protection (standards and practices, etc.) and if not, what should be done to provide same? The FAA has been considering and reconsidering, investigating and reinvestigating these matters for at least 20 years. This is why the NAS was asked to provide recommendations. The NAS recommendation that the FAA again reevaluate this matter seems to be unacceptable.

A few more issues that deserve consideration:

The radiation issue—As mentioned by Mr. Trask, we are somewhat perplexed to find that the National Aeronautics and Space Administration (NASA) reports peak values of 8,000 millirem per hour at aircraft cruising altitudes and that such exposure can last for at least a few hours, while the Academy reports only 2,000 millirem per hour. Which is right?

Assuming this peak radiation level of 8,000 millirem/hour could last for 3 hours and that before and after that time there would be still high levels, what would the

24,000 millirem of exposure mean? To shed a little light on the issue we should like to point out that the relative biological effectiveness (RBE) of neutron radiation (which is prevalant at cruising altitudes) is far greater than x rays. In other words, neutron radiation is far more damaging. Fortunately, such exposures are infrequent; nevertheless, they do occur. The question is how serious is this radiation? We believe it is important that this be determined. Forty to forty-five millirems is the approximate exposure one receives from an anterior view chest x ray. A dental x ray is approximately 200. A skull x ray is 330. Although atoms, molecules, nuclear structures, and radiation are complex and, in some cases, not well understood fields of science; and there are many synergistic radiation effects to consider: the mathematics are simple—in other words, you can fit a lot of 40 or 200 millirem x rays into 24,000 millirem—the approximate equivalent of 120 dental x rays or 600 chest x rays on one cross-country flight!! Plus, this type of radiation causes more damage than x rays when it penetrates critical tissues.

The NAS is voicing concern over pregnant flight attendants who may have a maximum peak exposure of 2,000 millirem per hour. What would be the recommendation for 8,000? What would be the NAS recommendation for all those women who, during the first trimester when the radiation exposure is most-damaging, in many cases, are not even aware that they are pregnant. This then raises the issue of health and safety instructions to passengers relative to cabin air quality. By the way, cabin air quality as stated in the law includes pressure and radiation. The question the law seeks to answer is—should there be pre-flight instructions or information available to passengers pertaining to potential radiation exposure? Should there be monitoring equipment on board aircraft to alert the crew that there potentially may be hazardous levels of radiation? Should the public be informed about low pressures that they may encounter during travel, etc.? Unfortunately, these and many other serious questions still remain unanswered today.

A final note on the radiation issue which may be of interest is that scientific investigations reveal that neutron radiation has a debilitating effect on our immune system. The question is—do high levels of radiation periodically contribute to increased incidents of cold or influenza among air travelers? This, we realize, is a more long-term investigation for the NAS to consider.

I strongly support the NAS and trust that this Committee will see fit to provide the requisite support for the NAS to completely fulfill the requirements of Public Law 98-466.

On the other side of the coin, the FAA again seems to be posing as a hindrance in the pursuit of these investigations. We strongly suggest the FAA be as completely removed as possible from any further studies or investigations under this law. Ultimately, a change of the FAA charter, as recommended by Mr. Trask, would be most appropriate. It is long overdue.

I believe it is important that we remind ourselves, and the FAA, that the ultimate purpose of the law is "in the interest of health and safety and in the interest of promoting and maintaining a superior United States aviation industry," a quote from Section (1a) of Public Law 98-466 [the section omitted by the FAA].

We thank you for the opportunity to present our views and trust our comments will be of value to the Committee. We wish the Committee and the NAS well in its endeavors and look forward to a new report which will fulfill the requirements of the law.

AVIATION SAFETY AND HEALTH ASSOCIATION,
Honolulu, HI, November 5, 1986.

Hon. ERNEST F. HOLLINGS,
U.S. Senate, Committee on Commerce, Science and Transportation, Washington, DC.

DEAR SENATOR HOLLINGS: Your letter of October 14, 1986 forwarding several questions to the Aviation Safety and Health Association on behalf of Senator Inouye concerning the September 19, 1986 Senate hearing on the National Academy of Science's report on airline cabin air quality, received in my office on October 20, 1986, is acknowledged.

The Aviation Safety and Health Association (ASHA) welcomes this opportunity to provide additional comments. We will answer them in the order submitted.

1. What agency do you feel should be responsible for monitoring and regulating aviation health issues?

Any agency that will be assigned the responsibility for monitoring and regulating aviation health issues should have medical personnel (i.e. physicians) and personnel who understand the environment aboard an aircraft and how it is created and with familiarity of aircraft manufacturing.

We believe that the appropriate agency should be the Federal Aviation Administration, however, only if it is restructured to solely promote public safety and health (We refer you to our answer to question No. 5 below).

2. How do you think the traveling public could most effectively be informed of the dangers associated with the varying and sometimes high pressurization levels of the aviation environment?

The FAA has stated previously that the airlines do not pressurize the cabin environment in excess of the 8,000 foot oct level. The ATA emphatically states that airlines do not exceed an interior cabin pressurization of 5,700 feet. However, the NAS study states that warnings of inadequate pressurization commences at the 10,000 foot level. We believe the oxygen masks do not deploy automatically until 11,000 to 12,000 feet.

One of the ways to protect the public is to mandate, monitor and regulate an appropriate level of cabin pressure.

We believe one of the ways to inform the passengers is through their physicians. Another alternative would be to include information on the altitude the aircraft will fly enroute to a destination in the pre-flight safety instructions to passengers.

3. Do you think the traveling public would be willing to pay the extra costs associated with providing adequate airflow? How about the costs of providing emergency breathing equipment for all passengers?

We believe the traveling public already assumes that the price of their ticket includes the cost of providing adequate fresh-air-ventilation to protect them from suffering the debilitating effects of high altitude jet travel.

We also believe that the traveling public already assumes that the price of their ticket includes all necessary emergency breathing equipment. We've found that the public believes that the emergency oxygen masks will be deployed in the event of an inflight fire. We know that aircraft manufacturers have specifically warned against deployment of emergency breathing equipment in the event of inflight fires.

4. ASHA stated that it was aware that radiation levels from sporadic solar cosmic rays can increase to exceedingly high levels (of the order of 8,000 mrem/hr.), and persist for periods of a few hours. What does this mean to flight attendants working average shifts? Should frequent fliers also be concerned by these levels? What do you propose as a way to address this problem?

The 8,000 mrem/hr. figure was obtained from an article by J. W. Wilson, NASA Langley Research Center, 1981, entitled "Solar Radiation Monitoring for High Altitude Aircraft."

In direct response to this question, ASHA has found the following relevant information:

1. The appropriate exposure to an anterior view chest x ray is 40 to 45 mrems;
2. A dental x ray is approximately 200 mrems;
3. A skull x ray is 330 mrems.

Based on the above information, assuming a five hour cross-country flight (equal to a possible exposure of 3 hours at 8,000 mrems/hr. = 24,000 mrems) could mean an exposure equivalent to 120 dental x rays or 600 chest x rays per cross country flight.

Frequent fliers should be concerned about the levels we predict because exposure is not limited to flight crews. Since it is our understanding that high radiation levels can be predicted, it appears that a warning should be given to the airline industry about the dangers of high altitude jet travel at the predicted time interval with instructions that airline operators warn appropriate employees and passengers. There may be occasion to ground all flights during the periods of such high intensities.

5. In your testimony you suggest that the Federal Act should be amended to focus on FAA's attention on Aviation Safety. What specific recommendations do you suggest?

Basically, the Federal Aviation Act has a dual purpose. The first is promoting air commerce, the second aviation safety. Initially, when the airline industry was a fledgling industry government support and promotion was understandable. However, as is apparent today, the airline industry is a thriving multibillion dollar business with strong lobbying associations located within the ATA and AIA.

Federal Government promotion of the airline industry over the safety aspect of the Federal Aviation Act is a conflict of interest, with the public interest and protection falling a distant second.

Since the industry is healthy enough to promote itself the federal government should withdraw its promotion and concentrate on the public safety. To do this, we believe all reference to the promotion of aviation commerce should be deleted from the act and the act should be amended to focus the entire efforts of the FAA on aviation safety.

In particular, there should be a division established within the FAA to monitor aviation safety and health issues, complaints or questions consistent with the NAS study recommendations. The division would require both medical and industrial technology. Flight attendant reports of aircrafts or flights should be collected by this division.

Health standards for flight attendants, pilots and other employees should be established by this division and enforced.

In conjunction with this amendment to the Federal Aviation Act, the Occupational Safety and Health Act should also be amended to allow OSHA to enter regulation of the airline industry as it relates to occupational safety and health and establish standards if the FAA fails to do it within 12 months of amending the Federal Aviation Act.

6. The Aviation Safety and Health Association (ASHA) believes the NAS study was a first step in many that should be taken to identify, review and recommend action on specific issues of aviation safety and health. A few of the items that require NAS study include, but are not limited to the following:

1. Confirmation of what industry practices are in the United States with respect to appropriate fresh air ventilation.

2. A determination of whether current industry practices are discriminatory as defined in the Commerce Committee Report No. 98-468, with respect to all 10 items required to be studied.

3. A comparison of foreign country aviation practices and a report on why they differ from the U.S.

Should we be able to provide additional information or answer additional questions, please do not hesitate to contact us at your convenience.

Very truly yours,

PETER L. TRASK.

Senator **KASSEBAUM**. Thank you very much.

Senator Inouye, do you want to start the questioning?

Senator **INOUYE**. Yes. Thank you very much.

I would like to ask Ms. Achenbaugh, on the last page of your statement, in discussing systematic measurement of carbon monoxide, suspended particles, microbial aerosols, ozone, et cetera, you say the following: "Many carriers refused to allow the National Academy of Sciences on board their aircraft to take measurements."

What airlines?

Ms. **ACHENBAUGH**. Senator, I may have to defer to Mr. Finucane.

Mr. **FINUCANE**. United Airlines published a statement that they were the only airline that agreed to go along with a National Academy of Sciences request that they be allowed to perform studies onboard aircraft.

The United Airlines statement criticizing the other airlines did not list the names of the other airlines, so we do not have those. But I gather the Academy probably went through the trade association and it was a generalized request.

Senator **INOUYE**. From that statement, could I conclude that all other airlines refused?

Mr. **FINUCANE**. No. We just said "many." That was our understanding of what United said when they said they were the only one.

Senator **INOUYE**. Did the association give any reason for refusing measurements taken onboard?

Mr. **FINUCANE**. The United Airlines statement describing this situation did not specify why the other carriers refused, but I think that this does clarify a very important issue, which is that if the Congress wants to see further studies in this area based on the National Academy of Sciences study, it is going to have to specify the right of whoever does those studies to go onboard the aircraft, because clearly the airlines are within their prerogative to say to NAS you can't come on and measure radiation.

They could probably say no to EPA. They might be able to say no to OSHA. That is not clear. And so we would urge the subcommittee to do further studies, to insist upon further studies, and if they are not done by the FAA, if they are done by another agency, to make sure it has statutory authority to go on board.

Senator **Inouye**. Madam Chair, may I ask Mr. Halfpenny that question?

Senator **Kassebaum**. Yes. I would like to hear his response.

Senator **Inouye**. What airlines refused the NAS to get on board the aircraft to take these measurements?

Mr. **Halfpenny**. We proposed the original testing, and United thought it would be nice to have three airlines, so then we proposed it to TWA and American Airlines, who thought it would be even better to have six or seven airlines. So then we added Delta, Northwest, I believe U.S. Air—I am not sure of U.S. Air—those are the ones I remember—and Eastern.

We had a big meeting and we reviewed the test plan and the general conclusion was that it was a no-win situation for the airlines. They felt that the program was not extensive enough and they wanted probably even more people to support it and everybody backed out but United.

Senator **Inouye**. Everybody backed out but United.

Mr. **Halfpenny**. Yes, sir. They still would like to have done the program but they did not want to do it alone.

Senator **Inouye**. Would it have caused them inconvenience or funds to take these measurements?

Mr. **Halfpenny**. Yes. The program that we had proposed required that we put two people on board with a fair amount of equipment. And as you know, Senator, on some of these long flights where they are crowded, it required some scheduling, it required probably a member of the airline staff to accompany us to make sure we get our equipment through security, on board, and get the captain's approval to conduct the test.

We felt it would take the support of at least one airline person on board and on the ground to run the test. It would have cost them a little bit, yes.

Senator **Inouye**. Ms. Achenbaugh, on the matter of radiation on which you have expressed much concern, are the flight attendants given much warning?

Ms. **Achenbaugh**. We are given no warning, Senator.

Senator **Inouye**. No warning?

Ms. **Achenbaugh**. No warning.

Senator **Inouye**. I was told that they are required to by FAA regulations.

Mr. **Finucane**. The FAA recently denied a petition for rulemaking by Edward Bramlitt, a health physicist, asking for standards in the radiation area. In the denial of the request for rulemaking the FAA said that it was considering requiring some kind of notification in the future, but they have not taken any concrete regulatory steps in that direction.

Of course, it is of great concern to us, and it should be a great concern to passengers, too.

Senator **INOUYE**. Is there any warning system aboard aircraft to warn crewmembers as to anything other than a huge fire? Do they give you warnings on excessive smoke?

Mr. **FINUCANE**. Nothing like that is measured on board the aircraft.

Senator **INOUYE**. What is measured?

Mr. **FINUCANE**. For example, they have an ozone standard, but the agency has never required measurements of ozone. So, as the Academy points out, the catalytic converter on board can be close to defunct and you will be getting tremendous amounts of ozone and there will be no warning.

It is clear that this solar flare activity can give you in one flight, if you are a passenger, more radiation than a whole series of medical x rays. The studies show that even small amounts of radiation, like a medical x ray, doubles your risk of childhood leukemia and cancer. So there may be situations on board aircraft that would double the pregnant passenger's risk of childhood leukemia or cancer and there is absolutely no warning.

This information could be gotten to the passengers.

Senator **INOUYE**. Are you given warnings on change in pressurization?

Ms. **ACHENBAUGH**. Generally no. We know what serving times are, and what schedules are, and when we are supposed to land. And as we descend depressurization begins, but as far as a warning that they are changing pressure, no; unless your ears start to pop and you feel a discomfort or you know about the time you are supposed to be landing.

There may be the notification that the seatbelt sign is turned on so you are starting a descent, or you will be starting shortly into descent. You learn as you fly what the airplane is doing and act accordingly.

Senator **INOUYE**. You have been extremely critical of the FAA, but you still suggest that the FAA is the appropriate agency for these rules.

Mr. **FINUCANE**. I think the best explanation for that is the old saying, "not invented here." The FAA is an agency that really does not like ideas that are not invented at the FAA. So if the FAA were to do some further studies and identify particular problems, the agency would really believe that there is a problem.

If it comes from the Academy, if it comes from the Safety Board, there is this natural skepticism at the FAA. So as disillusioned as we are with the FAA, we think that if it was given the proper direction from Congress, the proper funds, that it could do a good job and that in the long run you would probably see more regulatory change.

Senator **INOUYE**. Mr. Trask, do you believe that the traveler is given adequate information as to dangers associated with changes in aircraft pressure?

Mr. **TRASK**. No; I do not, Senator. I do not believe the flying public is given any information on the kind of circumstances that it is involved in, once it gets on an aircraft.

When a person goes to do an upper GI series or a lower GI series, I believe the physician asks them, the woman in particular, if she is pregnant because she is going to get some dose of x rays. And that warning is very bold in the doctor's office. No person has any kind of a warning as to what they are getting into when they get into an aircraft. They are assuming that the price of their ticket takes care of enough fresh air, takes care of toxic fume protection, takes care of getting them out of the aircraft in case of any kind of problem, and really the ticket price should take care of that. I just think we are all being a little bit confused here as to what the airlines are providing for the public.

Senator INOUYE. Ms. Achenbaugh, one of the prior witnesses suggested in response to my inquiry that passengers need not be advised about smoke and fire because it might just cause unnecessary concern and panic.

You fly all the time; you have been flying for 10 years.

Ms. ACHENBAUGH. I have been flying for 19 years.

Senator INOUYE. Do you think that is a correct assessment? Do you agree with that?

Ms. ACHENBAUGH. There is tendency in the airline industry not to want to tell too much to the traveling public, and many years ago when we were trying to get the safety cards upgraded and changed, to put what you need to know on the safety card on the assumption that it is the public's responsibility to know and if you do not know, buyer beware. But the airlines do not want to panic people unnecessarily and they do not want passengers taking responsibility for evacuating airplanes because they do panic in a situation when they are on the ground. However, there is some educating that needs to be done to the traveling public so they can protect themselves and survive when something goes wrong.

Fortunately, there are not that many times when something drastic does go wrong. But we are also living in a new age now with terrorism and a lot of other hysteria, and people need to know that they can protect themselves and be protected.

Senator INOUYE. You were not clear as to whether cigarette smoking should be banned. Do you have any position?

Mr. FINUCANE. Senator, let me answer that question. We would like to see cigarette smoking banned on all flights. We have one small reservation which has to do with long flights. Our estimation of human nature is that on long flights there might be some clandestine smoking in the lavatory.

On the other hand, there are smoke detectors. But let me just clarify one thing about that. There is clandestine smoking in the lavatories today in the current situation, and the current policy of allowing smoking encourages that. Basically, the back section of the aircraft is kind of a smoking party. It is a smoking salon, and that psychology extends to the aft lavatories. People go in there and smoke.

If you ban smoking, I think at least on short flights you would see a decrease in smoking in the lavatories. So we would like to see a ban on smoking on all flights. We do have reservations about long flights, though.

Senator INOUYE. Do you agree with that, Mr. Trask?

Mr. **Trask**. We are taking the position that there is enough equipment on board. We are not requiring anything to be put into the aircraft, just to turn it on.

Mr. **Finucane**. Just to add to that, the National Academy of Sciences study states fairly clearly that it is their belief that modifications of the on board system, major modifications of the ventilation system would be needed to accommodate smoking and that you can't really accommodate smoking on the current aircraft in terms of the ventilation rates provided. That is the Academy's position.

Senator **Inouye**. Thank you very much.

Senator **Kassebaum**. Yes. I would like to pursue this topic for a moment. Mr. Trask, in your testimony, you indicate that British Airways and the Scandinavian Airlines system operate their airpack equipment at all times.

Are you saying that this practice cures the problem of excessive cigarette fumes?

Mr. **Trask**. Yes, Senator. What ASHA believes is that there is enough equipment onboard. And what we have to do is the way the aircraft were certified, and since the time that the aircraft were certified there has been an increase in the number of passengers, so there have been more seats, so now it looks like the equipment is not adequate.

But basically, if they were run on full, all three of them, we believe that there is enough equipment on board to clear not just the smoke, but it operates like a flushing action from forward to back to take along with the smoke the easy stuff that you can see, other contaminants along with it.

The problem is when you have an increased density and you have people getting almost 2.5 cubic feet per minute per person of fresh air and 59 percent of it is the sweat and breath of other people, you start to wonder what kind of environment do we have here?

So I think if it is turned on and used and utilized, I think it should resolve most of the questions really.

Senator **Kassebaum**. Our carriers have the same number of airpacks, however. You are just saying they do not use them all the time?

Mr. **Trask**. Yes. As part of our testimony we attached an exhibit B which is a DC-10 flight manual handbook. There is a page there and it said—if I may get to the right point—here it is—it says here on the first page of exhibit B, "Avoid three-pack operation." So there is a policy there.

And then it goes on to say that if you have a problem with ventilation, then go two packs auto low, one pack auto high, one pack auto low, two packs auto high, then three packs auto low, three packs auto high.

So what we are saying is we have an operating policy where they can operate the number of airpacks and the velocity of those airpacks. And to us, we believe that if you are going to run an aircraft and put on more seats and accommodate a higher density, then this policy of running a lower or less reduced fresh air ventilation does not work.

It starts to create the environment where things are getting congested. So I think the capability is there; the policy is just not to provide it.

Mr. **Finucane.** Senator Kassebaum.

Senator **Kassebaum.** Mr. Finucane.

Mr. **Finucane.** May I add one thing? My impression of the Academy study was that current aircraft are really operating around 7 cubic feet per minute. If you were to run all the packs on many of these aircraft, you are getting maybe 20 cubic feet per minute.

The Academy's estimation is that—at least at one point in the study—you need 50 cubic feet per minute to accommodate smoking in the aircraft. And so it may be, according to the Academy that the ventilation is inadequate to accommodate smoking.

In addition, you would have to assume that the ventilation systems were going to be adequately maintained, which is often not the case. So even if you had a policy of running all the packs, poor maintenance could lead to, on many flights, a decrease in air quality.

Finally, it is not an either/or situation. The ideal situation would be to provide full ventilation and to reduce smoking.

Senator **Kassebaum.** Have British Airways or Scandinavian Airline done any studies? Do you know what their policy is, Mr. Trask, or of any of the other foreign carriers with respect to the optimum levels of cabin ventilation?

Mr. **Trask.** It is my understanding it is under consideration and they are actively in practice right now. What I would like to do if the Senator would not mind, I would like to be able to provide the specific answer to that along with the documentation for those levels for both airlines.

Senator **Kassebaum.** All right. Thank you.

Those are all the questions I have. Senator Exon.

Senator **Exon.** Thank you, Madam Chairman.

Ms. Achenbaugh, let me ask you this question that I asked of earlier witnesses. As a member of the flight crew, I assume you agree with my position that if we are going to ban smoking from the passengers, we should also ban smoking among the crew?

Ms. **Achenbaugh.** Yes, sir. I do.

Senator **Exon.** Thank you.

Mr. Finucane, let me ask you this question about your testimony on testing of air quality among the airlines. I salute the effort of trying to determine what is the quality of air in our cabins today and I think it is quite proper that, directly or indirectly, you saluted United Airlines, and I compliment United Airlines for their forthcoming attitude.

I believe this is typical of United Airlines—they are very public relations conscious and I think they have a major concern about this.

I would encourage the other airlines, however, to follow the lead of United in this particular proposition. The only comment I would like to make, that while we are passing out these accolades, I suspect that this might be one of the outgrowths of deregulation. Deregulation, no question, has benefited the major airlines like United, who will be one of the four or five that is left after this morass that we are going through now and haven of cheap fares is all over. Then watch them go.

So I salute United Airlines. I like to travel on United, and I think they are a great airline. But I would simply say that what is fair and reasonable for United Airlines might not necessarily be fair and reasonable for the other airlines.

Would you agree that it might be a little bit easier for United to accommodate the inconvenience and expense than maybe some of the other carriers?

Mr. **Finucane**. I think they certainly could afford the inconvenience and expense. I think it was a little risky for them—or for any of the airlines participating—in terms of what might be discovered.

What we would like to see is a study chartered from this Congress, or through existing FAA funds, that would involve going on to all the carriers and treating them all fairly, and we see no reason why the agency would have to disclose the results from the individual carriers. What we need is some general information. What is the situation out there on the aircraft? How bad it is it? And do we need further regulations?

Senator **Exon**. While your suggestion may be worthwhile, you know it is very typical of everything that we do today, everything that we undertake, the Federal Government has got to put up the money to do it. The fact of the matter is, the Federal Government does not have the money to do it.

It seems to me, from what little I know of this, that with some kind of a reasonable approach, it would not be very expensive for the largest 6 to 10 carriers in the United States to undertake some kind of a study like this. I suspect that they are more fearful this might get out of hand. If I were the president of an airline and something like this came up, I would say, good Lord, every other flight that takes off from O'Hare International Airport is going to take up three or four seats and half of our lift capability to accommodate this.

I would encourage all airlines and for each of you to work together to see if you could not work out some kind of a proposal that most airlines would go along with.

My last question, Madam Chairman, is directed to Mr. Trask. Mr. Trask, I listened very carefully to your testimony and I guess what you were saying was something that I was trying to bring out in the questioning of the other witnesses. And that is that if there was a little bit of ingenuity in the future designs of aircraft—if for example when an airline orders an aircraft, it might cost them more to provide an area where smokers could be set off by themselves—maybe just a little ingenuity in design and accommodation might solve the problem of whether we need further Government regulations.

Was that the thrust of your testimony?

Mr. **Trask**. I guess I should say yes, sir.

Basically, I think our thrust is this. We have an environment where we have a captive audience. We have a system of airlines or an industry that really technically act like a common carrier. If anybody wants to get anywhere within a reasonable amount of time, they usually fly; they have to fly.

And because this environment at 30,000 or higher feet is captive and enclosed, we feel that some attention should be paid for what is going on in that environment. If it means that the industry should change or alter their configuration, if it means that they should turn on or exhibit some kind of new policies or enlightened policies so that they can take care of the comfort, they can take care of the health issue, they can take care of the radiation, humidification and all of that, and if it means that unless they do it, the Federal Government is going to do something about it, I would think that it would be in the best interests of the industry itself to take care of it now, because it takes almost, I understand, 3 to 4 years to certify an aircraft.

So the current generation aircraft we have now really has been certified recently or started certification process 3 or 4 years ago. We are running into a problem here that if we do not take care of it now, we are going to perpetuate this problem for a lot longer time.

It is my understanding now that flight attendants are flying for 24 years. I am attorney and I represent several flight attendants who have had the 20-percent impairment of a lung disease; who have been rated 15 percent or lost one of their lungs. I get calls from Phoenix, AZ, or from Chicago, asking to represent attorneys or consult with attorneys about people who have a collapsed lung. They do not know where to turn. And this is after 19 years of being a flight attendant.

I think that we have some serious concerns here, but we just cannot tell the parameters of it because it is so big, it is so general, it is so new. I think that if the industry really wants to do something about it now, now is the time before it really gets out of hand and we certify another generation of aircraft. And if it is configuration, I agree with the Senator, if it is new policy to turn on the equipment, I am all for that.

Senator EXON. Thank you. I like your suggestion that if we could come up with some of these improvements to provide some smoking area—I think we all agree that the main problem is with regard to long flights.

You said that even at the maximum, the estimated cost for providing this would be about $1 a passenger. I would carry that one step further. If I have a habit of smoking that is objectionable to other people, you know I do not like that—and it is objectionable to other people, including my wife.

But I simply say that I try the best I can to accommodate other people's concern. I would not mind, at least to engineer some thinking along the lines that since we have today in the commercial airline industry classes of passengers, first class passengers, business, and coach, why couldn't we have a proposition that I, as a smoker, would pay more if I boarded a flight that had smoking privileges?

I am not sure that it would be fair to, even if it is only a dollar, to have some people subsidize a shortcoming that I have. I am saying that if we could engineer some thinking along the lines that if I want to smoke on an airline, where I would pay $2, $3, or $5 more for "that privilege," it could be used as an additional incentive for drawing more people onto an airline.

I would more likely schedule myself on an airline that had such a facility available to me than an airline that did not. So I guess that those of us who do it, should pay for it, rather than the public at large.

Mr. **Trask**. Senator, I think if most smokers had your frame of mind, it would be OK. I think the other half of that coin would be that people would think they would be penalized by having to pay more just to fly that airline. I do not want to get into that penalization aspect of it.

But basically I think the airlines have a great public relations opportunity here, and that is if they want to say United Airline flies you first, second, steerage class—as the Senator said—and we will give you 100 percent fresh air throughout the entire flight for $1 extra more, I would bet dollars to doughnuts it might work.

Senator **Exon**. Well, I would just say in closing that, as a smoker, I am sensitive to others' concerns. If you want to expand this, if we ever introduce legislation, if you want to expand this to ban all smoking everywhere, including the U.S. Senate—except pipe smoking—then I will go along.

Senator **Kassebaum**. Senator Inouye.

Senator **Inouye**. I would like to thank Mr. Trask for taking this long, tedious flight from Hawaii to be with us this morning. As the Chair may remember, Mr. Trask was on the staff of this committee at one time.

Senator **Kassebaum**. I want to thank Senator Inouye again for helping focus us on this issue. And I hope, given the basis of the Academy of Sciences report, that we can move forward and I assure you, Senator Inouye, and others who are interested, that out of this perhaps we can come forward with some constructive recommendations and not just let the issue continue to languish.

Legislation may not be necessary but I think this issue requires some innovative thinking on the part of everyone involved.

Thank you again, and I thank the witness here this morning.

[Whereupon, at 11:56 a.m. the hearing was adjourned.]

[The following information was subsequently received for the record:]

Citizens Against Tobacco Smoke,
Cincinnati, OH, September 26, 1986.

Re Submitting for the record a statement concerning cabin air quality as it relates to the National Academy of Science's study, "The Airliner Cabin Environment: Air Quality and Safety."

Senator Nancy Kassebaum,
Chairperson, Subcommittee on Aviation, Senate Committee on Commerce, Science and Transportation, Dirksen Senate Office Building, Washington, DC.

Dear Senator Kassebaum: I would appreciate your entering into the record[1] as evidence submitted by me the document titled "A Pilot's Guide to Cabin Air Quality and Fire Safety" from the July, 1985, New York State Journal of Medicine written by H.B. Fulton, Jr., a pilot for Eastern Airlines.

In my letter to Senator Danforth of September 15, I requested the opportunity to submit testimony and, to date, have heard nothing from the Committee about hearings on the N.A.S. report. However, a day before your Aviation Subcommittee hearing I did receive a call from someone at the National Research Council alerting me to the hearing date. Unfortunately there was not enough time to gather together the documentation and give testimony from pilots, flight attendants, and the public that we want to submit. Therefore, we would appreciate the opportunity to present witnesses and documentation that may change the perception left by The Tobacco Institute regarding public opinion of air travelers and whether or not secondhand smoke is harmful to them. In addition, the National Research Council is aware of the fact that we have evidence to submit that will not only further document the necessity to ban smoking on airliners, but the expert witnesses we are aware of were exactly the kind the NRC was seeking during its investigation. One of these men has had a career that spanned 41½ years at the Boeing Company. His testimony is most revealing and should certainly be considered by the subcommittee.

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[1] By reference.

We would appreciate the opportunity to testify before your subcommittee after Congress reconvenes in 1987. I look forward to receiving your reply.

Sincerely,

AHRON LEICHTMAN, *President.*

THE TOBACCO INSTITUTE,
Washington, DC, October 31, 1986.

Hon. NANCY KASSEBAUM,
Chairman, Aviation Subcommittee, Committee on Commerce, Science and Transportation, U.S. Senate, 428 Senate Hart Office Building, Washington, DC.

DEAR MADAM CHAIRMAN: I am writing in reference to the hearing before your subcommittee on September 19 which addressed the issue of airliner cabin air quality. We very much appreciate the objective and balanced approach taken by you and your subcommittee, especially in view of what we consider to be the unsupported recommendations of some witnesses.

During the hearing the National Academy of Science presented testimony on its recommendation to ban smoking on all domestic flights, and the American Medical Association submitted a statement for the record supporting the recommended ban.

We oppose the views presented by the National Academy of Science and the American Medical Association, and respectfully request the enclosed documentation be included in the official record of the hearing. A brief summary of these enclosures follows:

1. The Tobacco Institute's submission to the National Academy of Science concluding that no medical evidence exists showing environmental tobacco smoke endangers the health of passengers or crew aboard aircraft.

This submission also refers to an independent poll taken which concluded that 82 percent of air travelers are satisfied with the current arrangement of smoking and non-smoking sections aboard aircraft. Statistical data from this poll is available upon request.

2. A summary of an examination made by Philip Schaenman of National Transportation Safety Board reports of serious fires aboard aircraft which concluded there is no reason to curtail smoking on board aircraft for fire safety reasons because the chance of fires from smoking is very low.

An explanation of Schaenman's development of these findings is contained in his full report and is available for review upon request.

Thank you for the opportunity to submit our views.

Sincerely,

SAMUEL D. CHILCOTE, Jr.

Enclosures.

THE TOBACCO INSTITUTE,
Washington, DC., May 31, 1985.

COMMITTEE ON AIRLINE CABIN AIR QUALITY,
National Academy of Sciences, 2101 Constitution Avenue, Washington, DC.

DEAR SIRS: The Tobacco Institute submits these comments on the aircraft cabin air quality study (the "NAS study"), currently being conducted by the Committee on Airline Cabin Air Quality, National Academy of Sciences ("Committee"). The Institute, which represents major manufacturers of cigarettes, welcomes scientific inquiry into the host of issues relating to cabin air quality. Although tobacco smoke is one of many matters that the Committee may address, it is not specifically mentioned in either the study's authorizing legislation or the Senate Committee Report, or in your Notice.

As a political and social issue, smoking aboard aircraft has been the subject of repeated rulemaking proceedings over the past 12 years before the Civil Aeronautics Board ("CAB"), the agency formerly responsible for aircraft smoking regulations. These issues finally were resolved last summer following lengthy hearings and review of extensive comments from a multitude of interested persons.[1] The proceedings culminated in the CAB's determination that "smoking remains a socially acceptable practice," and the issuance of final rules to accommodate smoking and nonsmoking passengers. In fact, an opinion poll conducted in April 1985 for The Tobacco Institute by Tarrance & Associates reveals that an overwhelming majority (82 percent) of the public is satisfied with these rules and believes they should not be changed.[2]

Appropriately, the Committee's designated role is to undertake scientific inquiry, rather than to revisit this regulatory debate.

THE UNIQUENESS OF THE AIRCRAFT CABIN ENVIRONMENT

The Committee's authorizing legislation directs the Committee to recognize the unique nature of the aircraft cabin environment: "In conducting the study, special and objective considerations shall be given to the uniqueness of the environment onboard civil commercial aircraft." [3] Accordingly, any Committee consideration of tobacco smoke particulates can appropriately be addressed only in the context of this unique environment. As the CAB recognized only last year in refusing further to regulate aircraft smoking "on the specific basis of the health aspects of passive smoking" in non-aviation environment, "no commenter has shown that the findings of [passive smoking] studies are applicable to the situation aboard aircraft." [4]

The modern aircraft cabin is in fact designed to provide a uniquely ventilated environment, effective in dealing with tobacco smoke. Indeed, FAA experts have repeatedly testified that aircraft cabin ventilation systems are "fully adequate." [5] Within the last two years, the FAA specifically found "no need to require changes in aircraft ventilation systems" to deal with tobacco smoke "from a health perspective." [6]

Aircraft cabin air flow rates compare favorably with recommended standards of non-aviation environments and provide passengers ventilation three to five times that recommended by the American Society of Heating, Refrigerating and Air-Conditioning Engineers.[7] By recent regulation, moreover, smoking is permitted only when ventilation systems are "fully functioning" to provide ventilation meeting design specifications.[8] Aircraft manufacturers have further demonstrated that industry practices and standards not only "surpass non-aviation standards" in certain areas, but also that those practices and standards "are continuously improved." [9]

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[1] These proceedings involved appearances by at least two government agencies, fourteen airlines or airline organizations, six labor unions, eleven consumer groups, four tobacco groups, and others, individual letter comments to the Board from more than 20,000 individuals, and 3 days of oral argument in which 42 people, including ten members of Congress, expressed their views. See 49 Fed. Reg. 25408 (1984).

[2] A copy of the Tarrance poll is attached.

[3] Public Law No. 98-466, 1, 98 Stat. 1825 (1984).

[4] As the CAB concluded last year in specifically refusing further to regulate on the grounds of claimed health effects of "passive smoking," the evidence regarding claimed health effects of environmental tobacco smoke "is still being disputed." 49 Fed. Reg. 25410 (1984). As the CAB explicitly also recognized, studies of "passive" smoking effects in nonaviation environments are inapplicable to the aircraft cabin environment: "The cited studies involved smoking in the home or office, places where people spend a significant portion of their life. This differs from the situation aboard aircraft where most people spend a relatively short time. Aircraft also differ from homes and offices in that nonsmokers are separated from the smokers in the former, but usually are not in the latter." 49 Fed. Reg. 25410 (1984).

[5] Cabin Air Quality: Hearing on S. 197 Before the Subcomm. on Aviation of the Senate Comm. on Commerce, Science, and Transportation, 98th Cong., 1st Sess. 9 (1983) (statement of Craig Beard, Director, Office of Airworthiness, Federal Aviation Administration) [hereinafter "FAA Statement"].

[6] Id. at 10.

[7] The FAA's review of the ventilating characteristics of seven current transport aircraft in 1981 revealed that "the ventilation varies from 15.2 to 25.7 cfm/person in the passenger cabin or 3 to 5 times that recommended by ASHRAE." U.S. Department of Transportation, Federal Aviation Administration. In the Matter of the Petition of Xenex Corporation, Denial of Petition, March 3, 1981.

[8] 14 C.F.R. § 252.3(a) (1984).

[9] Airliner Cabin Safety and Health Standards: Hearing on S. 1770 Before the Subcomm. on Aviation of the Senate Comm. on Commerce, Science, and Transportation, 97th Cong., 2nd sess. 52 (1982) (statement of John Reese, Director of Airworthiness Programs, Aerospace Industries Association).

THE EVIDENCE DOES NOT DEMONSTRATE AN ADVERSE HEALTH EFFECT ON PASSENGERS FROM SMOKING ABOARD AIRCRAFT

Available scientific data fail to demonstrate that smoking aboard aircraft causes an adverse health effect in nonsmoking passengers. The only study to deal specifically with the situation aboard aircraft—conducted by the Federal Aviation Administration (FAA) and the National Institute for Occupational Safety and Health (NIOSH) in 1971 concluded that the "low levels of contaminants measured do not represent a health hazard to the non-smoking passengers on aircraft." [10]

Significantly, these findings were based on studies of smoking aboard aircraft conducted before the CAB issued rules in 1973 requiring segregation of smokers and nonsmokers in separate sections of the cabin.[11] Moreover, these studies were undertaken prior to the recently-issued CAB regulations prohibiting pipe and cigar smoking or smoking while an aircraft is on the ground or when the ventilation system is not "fully functioning" up to design specifications.[12]

On the other hand, no reputable medical evidence has been found to contradict the FAA's 1971 conclusion that exposure to environmental tobacco smoke in the unique aircraft cabin environment presents no adverse health effects for nonsmoking passengers. Dr. Robert L. Wick, medical director for American Airlines, former professor of preventive medicine at Ohio State University and chairman of the Division of Environmental Medicine, aptly summarized the state of the medical evidence in 1982 Congressional testimony:

> There is nothing in the literature today which would suggest that there is a significant hazard to a healthy individual from casual exposure to smoke in an airplane, albeit it is unpleasant.[13]

To the contrary, the FAA reaffirmed its 1971 conclusion just 18 months ago, in Congressional testimony on the adequacy of modern aircraft ventilation:

> It is the FAA's view that casual exposure to 'second hand' cigarette smoke in a reasonably ventilated environment is not expected to have any relation to cardiovascular or pulmonary disease causation. . . . Therefore, from a health perspective, we have seen no need to require changes in aircraft ventilation systems.[14]

In so reaffirming the 1971 study in 1983, the FAA had available virtually all of the studies claimed to suggest health effects of smoking on nonsmokers in non-aviation environments.

In addition, the FAA's medical expert, Deputy Federal Air Surgeon Dr. Jon L. Jordan, testified before Congress in 1983 that the 1971 FAA/NIOSH study "revealed that there were minimal contaminants in the [aircraft cabin] air, especially in reference to cigarette smoking, and none of those posed a health hazard problem to either the passengers or crew." [15]

Recent research continues to support this conclusion. Only last year, for example, researchers from the San Francisco General Hospital Medical Center reported the results of a study conducted to measure the exposure of nonsmoking flight attendants to carbon monoxide and nicotine during a flight from Tokyo to San Francisco. The researchers found that blood carbon monoxide levels actually decreased during the flight. Moreover, the researchers concluded that the "concentrations [of nicotine] achieved are unlikely to have physiologic effects." [16]

CONCLUSION

The Tobacco Institute welcomes scientific inquiry by the Committee into the many issues relating to air quality in the unique aircraft cabin environment. To the extent the study touches upon the issue of tobacco smoke particulates in the aircraft environment, the Institute urges careful attention to the fact that there exists no reported medical evidence that these particulates in cabin air endanger the health of passengers or crew. To the contrary, the only significant evidence is that aircraft cabin smoking poses no such health concern.

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[10] See 38 Fed. Reg. 12207, 19048 (1973).

[11] 38 Fed. Reg. 12207-12211 (1973) (codified at 14 C.F.R. § 252.1-.5).

[12] 49 Fed. Reg. 25408-25420 (1984) (codified at 14 C.F.R. § 252.3, 252.4)

[13] Airliner Cabin Safety and Health Standards: Hearing on S. 1770 Before the Subcomm. on Aviation of the Senate Comm. on Commerce, Science, and Transportation, 97th Cong., 2nd sess. 113 (1982) (statement of Dr. Robert L. Wick, American Airlines).

[14] FAA statement, supra, at 10.

[15] Cabin Air Quality: Hearing on S. 197 Before the Subcomm. on Aviation of the Senate Comm. on Commerce, Science, and Transportation, 98th Cong., 1st sess. 12 (1983) (statement of Dr. Jon L. Jordan, Dep. Federal Air Surgeon).

[16] Foliart, et al., "Passive Absorption of Nicotine in Airline Flight Attendants," 308(18) N. Eng. J. Med. 1105 (1983).

Respectfully submitted,

SAMUEL D. CHILCOTE, Jr., *President.*

SUMMARY OF RESEARCH BY PHILIP S. SCHAENMAN ON AIRCRAFT FIRES FROM SMOKING

Philip S. Schaenman, a renowned expert in fire data analysis, recently examined the occurrences of fire aboard aircraft and concluded there is no reason to curtail smoking onboard aircraft for fire safety reasons because the chance of fires from careless smoking is very low.

Mr. Schaenman is President and Founder of TriData Corporation of Arlington, Virginia which specializes in information systems and data analysis for government and industry, especially in fire protection. His expertise and advice is often sought by many industries, fire departments, and the Federal Government in fire data analysis. He is a member of the National Fire Protection Association's Fire Reporting Standards Committee and once served as Associate Administrator of the U.S. Fire Administration.

In researching aircraft fires from smoking, Schaenman reviewed reports from 65 serious fires that occurred aboard U.S. carriers from 1970 through 1984, as reported by the National Transportation Safety Board. Of these, none have been positively determined to have been smoking related. One 1983 fire originating in a restroom (where smoking is prohibited) may or may not have been smoking related, and there were no injuries and only minor damage to the aircraft from this incident. Schaenman believes that this restroom fire would have been detected early or extinguished prior to damaging the aircraft if the now-required wastebin automatic sprinklers and lavatory smoke detectors were in place.

The analysis by Schaenman also indicates that although some anti-smoking groups have suggested that cigarette fires are a major hazard aboard aircraft, statistics and case histories of the NTSB clearly show just the opposite. In fact the evidence shows significant fires from cigarettes are extremely rare, and may vanish altogether with new safeguards now in place.

NTSB's definition of what constitutes an accident, including fire accidents, and the statistical development process are available for review upon request.

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